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ERGONOMICS IN THE REHABILITATION OF LOW BACK DISABILITY CASES: TOWARDS DEVELOPMENT OF AN EVALUATION FRAMEWORK THAT FOSTERS TEAM COLLABORATION

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Cette thèse intitulée:

ERGONOMICS IN THE REHABILITATION OF LOW BACK DISABILITY CASES:
TOWARDS DEVELOPMENT OF AN EVALUATION FRAMEWORK
THAT FOSTERS TEAM COLLABORATION

présentée par: COSTA-BLACK Kátia

en vue de l'obtention du diplôme de: Philosophiae Doctor

a été dûment acceptée par le jury d'examen constitué de:

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This work is dedicated to three people: my mother, Neusa Maciel, for always believing in me; my daughter, Amina Black, who inspires me to keep going; and to the love of my life, Lucas Black, for always challenging me in so many ways.

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RÉSUMÉ

Contexte: Les coûts et la souffrance humaine associés au phénomène d'incapacité lié aux maux de dos continuent d'augmenter malgré un volume important de recherches sur le sujet. L'un des moyens de prévention et de gestion des incapacités au bas du dos les plus prometteurs consiste en un modèle de réadaptation qui prévoit une procédure structurée de retour au travail axée sur des solutions de retour précoce, sécuritaires et durables. Ces programmes, fondés sur des données probantes, exigent une collaboration interdisciplinaire efficace et continue pour faciliter des solutions de travail qui soient à la fois centrées sur l'individu et sur son environnement de travail. Il existe actuellement peu de connaissances sur le sujet de l'intégration des outils d'ergonomie dans le milieu de la réadaptation. Il est donc particulièrement important d'effectuer d'autres recherches sur ce sujet.

Objectifs: Cette thèse of pour objectif principal d'explorer et de décrire la pratique en ergonomie de la réadaptation en ce qui a trait au contenu des évaluations ergonomiques et aux outils utilisés pour le retour au travail de travailleurs ayant des problèmes au dos. En se basant sur la littérature scientifique et sur les connaissances pratiques quant à au contenu des évaluations de poste de travail, au processus d'évaluation et aux outils utiles, cette recherche vise à jeter les bases d'un cadre d'évaluation pour les praticiens ergonomes impliqués dans le retour au travail de travailleurs ayant des problèmes au dos (objectif secondaire).

Méthodes: Ce projet se divise en trois phases. La première phase consiste à comprendre et déterminer le contenu de l'évaluation ergonomique. Celle-ci est réalisée par le biais d'une collecte de données empiriques tirées de plusieurs études de cas, de l'avis d'experts et d'un consensus de groupe sur l'identification de toutes les dimensions de l'environnement de travail pour la réhabilitation et le retour au travail liés aux lombalgies. La deuxième phase consiste en l'identification des outils existants et de leur applicabilité à ce type de pratique. La dernière phase consiste à développer un outil d'aide à la décision à partir d'un algorithme basé sur les résultats de trois études, en combinaison avec quelques prémisses importantes de la réadaptation fondée sur des données probantes.

Résultats: Compte tenu du fait que les connaissances sur le rôle de l'ergonomie de réadaptation dans les programmes de réadaptation sont peu développées, les bases d'un cadre désisionnel destiné à l'ergonome oeuvrant dans un tel programme est présenté de même que la logique dans laquelle s'incrit le développement de ce cadre. Nous avons identifié d'importants écarts existant entre la pratique et la recherche et nous proposons de nouvelles hypothèses pour favoriser de meilleures pratiques de réadaptation prenant en compte l'ergonomie.

Conclusions: En élaborant un outil explicitement adapté aux réalités des programmes de réadaptation actuels, cette recherche contribue à l'avancement des connaissances sur la pratique en ergonomie en élaborant un outil explicitement adapté aux réalités des programmes de réadaptation actuels. Le nouveau cadre proposé pour la collecte d'informations en milieu de travail pourrait, plus précisément, fournir aux ergonomes un moyen de collaborer plus efficacement au sein des équipes de réadaptation. De plus, il prévoit une structure formelle pour le processus et le contenu des évaluations ergonomiques. Ainsi, cet outil permettra non seulement de faciliter une meilleure collaboration interdisciplinaire, mais aussi d'aider les ergonomes à réaliser des interventions en milieu de travail plus efficaces et en rapport plus étroit avec la pratique de la réadaptation au travail fondée sur des données probantes. Des recherches plus approfondies devraient toutefois être réalisées afin de déterminer les avantages procurés par cet outil comme moyen de collaboration, et de tester son impact sur la détermination des solutions appropriées pour réduire le fardeau associé aux incapacités au bas du dos.

ABSTRACT

Background: Despite an impressive body of research explaining the impact of work factors on prolonged sickness absence related to back pain, the costs and human suffering associated with this disability phenomenon continue to rise. One particularly promising prevention and management strategy for low back disability (LBD) is a work-centered rehabilitation model which provides for a structured procedure focusing on early, safe and sustainable return-to-work (RTW) solutions. Such evidence-based programs require effective and on-going interdisciplinary and inter-organizational collaboration in order to facilitate workplace solutions centered on the individual and his/her working environment. Very limited knowledge presently exists regarding the incorporation of ergonomics methodology into this rehabilitation milieu, and thus more investigation is urgently needed.

Objectives: The primary objective of this dissertation was to explore and describe the practice of rehabilitation ergonomics in terms of the evaluation frameworks applied for the RTW of LBD cases. According to the scientific and practical knowledge gathered on workplace evaluations' content, process and tools, this research aims to take a step further and present a preliminary version of an evaluation framework for the ergonomist working in contemporaty rehabilitation/RTW programs (secondary objective).

Methods: This project was divided into three phases. The first phase relates to the understanding and determination of the ergonomics' evaluation content; this consisted of gathering empirical data via multiple case studies, experts' opinions and group consensus on the identification of all important work environment dimensions to the rehabilitation/RTW of LBD. The second phase was the identification of existing tools and their applicability to this type of practice. The last phase was the development of a decision support tool in an algorithm format based on the results of three studies, in combination with a few important premises extracted from evidence-based rehabilitation.

Results: Given the early stages of knowledge on the role of rehabilitation ergonomics within work rehabilitation programs, a preliminary decision-support

framework for the ergonomist working in rehabilitation programs is presented along with the foundations for its development. Important gaps between practice and research were identified and new hypotheses for the advancement of rehabilitation ergonomics best practices have been promulgated.

Conclusions: This research seeks to bridge scientific and practical knowledge related to the application of ergonomics as part of contemporary work rehabilitation programs, with particular focus on the workplace evaluations of LBD cases. It is hoped that the newly proposed framework might provide ergonomists with a means to more effectively communicate and collaborate with rehabilitation professionals and other stakeholders, since it provides a formal structure for the process of ergonomic evaluations. It is also expected that this framework might assist ergonomists to achieve more successful workplace interventions commensurate with evidence-based models for work disability prevention and integration. The implications for the utilization of such a tool are discussed. Further research is required in order to validate the framework as a tool to design more effective workplace solutions for reducing the burden associated with LBD. It is also necessary to test its usefulness as a collaborative asset.

CONDENSÉ EN FRANÇAIS

Modèles et théories de la gestion des incapacités

La littérature scientifique montre que l'incapacité au travail d'origine musculo-squelettique est un phénomène complexe et multidimensionnel qui résulte de l'interaction de nombreux facteurs liés à l'individu et à son environnement. Elle devrait donc être nécessairement gérée comme telle.

Au cours des dernières années, un effort concerté a permis de développer et mettre en œuvre des programmes efficaces de réadaptation visant à faciliter le retour au travail («return-to-work» ou RTW) des personnes affectées par des incapacités d'origine musculo-squelettique. Ces travaux novateurs en matière de programmes de réadaptation (également connus sous le nom de «RTW programs») favorisent un RTW précoce, sécuritaire et durable pour les personnes à risque d'incapacité prolongée (Yassi et al., 1995; Durand & Loisel, 2001a). Ces programmes sont adaptés aux besoins de chaque individu et mettent à contribution une équipe interdisciplinaire qui travaille de manière aussi indépendante que possible du milieu de travail et du système d'assurance, tout en restant néanmoins en étroite collaboration avec ceux-ci. L'objectif ultime de l'équipe est d'établir des partenariats entre les parties concernées afin de fournir au client une évaluation qui soit à la fois cohérente et organisée tout en étant associée à une gestion de cas appropriée.

Des données probantes récentes laissent croire que ces programmes devraient situer leur démarche de réadaptation au lieu de travail, bien que ces programmes aient été à l'origine développés en vertu d'un tel principe (Durand & Loisel, 2001a). La recherche que nous présentons ici s'appuie en partie sur cette réalité, ainsi que sur le contexte particulier du domaine, pour répondre à un besoin particulier associé aux nouveaux programmes de réadaptation/RTW. Les connaissances actuelles sur l'intégration de l'approche ergonomique dans le domaine de la réadaptation restent limitées et des recherches plus approfondies sont jugées nécessaires. Le processus d'évaluation ergonomique constitue un élément important qui a été très peu étudié jusqu'ici dans les écrits scientifiques touchant le RTW.

Le processus d'évaluation ergonomique

Une évaluation ergonomique du travail consiste en une collecte et une analyse systématique des données visant à établir les caractéristiques de la situation de travail d'une personne (exigences, attentes et caractéristiques de l'environnement de travail) affectant sa performance (Chengalur et al., 2004). Les informations obtenues lors d'une évaluation ergonomique du travail peuvent toucher des aspects physiques ou d'ingénierie, de perception et de cognition ainsi que sociaux et organisationnels (Vezina, 2001; Norman, 2003). Sur la base d'une compréhension globale de la situation de travail, les interventions ergonomiques peuvent aussi bien viser le «travail» au niveau de l'individu (micro ergonomie) que le travail au niveau de l'organisation où le travail est réalisé (macro ergonomie) (Norman, 2003). À ce titre, l'évaluation ergonomique est un processus de complexe documentation et d'analyse qui exige une vision systémique et une approche systématique.

Bien que le retour au travail soit généralement individualisé pour chaque travailleur, les ergonomes pourraient bénéficier d'une définition du processus fondamental et du cadre de leurs évaluations en milieu de travail en lien avec les incapacités liées aux lombalgies (« low back disability » ou LBD) dans le but de faciliter la communication avec les autres professionnels de l'équipe de réadaptation. Cette suggestion est en accord avec les avancées récentes sur l'étude du travail d'équipe en réadaptation ainsi que sur les modèles d'évaluation des troubles musculo-squelettiques.

Un certain nombre d'études ont récemment décrit les défis importants touchant la réalisation d'une collaboration efficace entre les membres des équipes de réadaptation. Ces études présentent aussi des solutions pour améliorer l'efficacité des communications entre les différents partenaires soit un aspect important de la collaboration (Friesen et al., 2001; Jakobsson et al., 2002; Pransky et al., 2004). En ce qui a trait à l'évaluation du milieu de travail d'une personne souffrant d'incapacité musculo-squelettique (y compris les incapacités associées aux maux de dos), la principale recommandation issue d'un ensemble important de recherches concerne l'importance de posséder une compréhension globale du profil d'exigences du travail de la personne concernée. Ce profil devrait idéalement être basé sur un cadre de référence qui soit à la fois logique et structuré de manière à permettre aux

utilisateurs d'obtenir facilement des informations selon différents niveaux de détail ainsi que voir les interactions entre les différents éléments.

L'objectif principal de cette thèse est d'explorer et de décrire la pratique en ergonomie de la réadaptation en ce qui a trait spécifiquement aux évaluations ergonomiques utilisées pour le retour au travail de travailleurs ayant des problèmes au dos. Sur la base des connaissances actuelles sur les évaluations ergonomiques, nous avons élaboré une hypothèse de recherche qui propose que les ergonomes travaillant dans les programmes actuels de réadaptation/RTW ont un besoin impératif de formaliser leur évaluation du travail afin de pouvoir recueillir, communiquer et partager de manière efficace les informations propres à chaque cas individuel. Conséquemment, l'objectif secondaire de cette recherche consiste à développer un cadre de référence permettant d'assister les ergonomes oeuvrant au sein d'équipes interdisciplinaires à réaliser l'évaluation du travail des cas d'incapacité liée aux lombalgies (LBD) dans une perspective de retour au travail. Cette recherche a été réalisée en trois phases:

Phase 1: définition du contenu de l'évaluation ergonomique du travail;

Phase 2: identification et analyse de l'applicabilité des outils d'ergonomie existants;

Phase 3: développement du cadre de référence.

Cette recherche a débutée par une recension des écrits qui explore les aspects essentiels du processus d'évaluation ergonomique (par exemple, la formation de l'évaluateur, l'expertise et les compétences nécessaires au domaine de la réadaptation/RTW) ainsi que l'étendue de l'évaluation en lien avec les modèles d'incapacité musculo-squelettique (chapitre 2). L'objectif principal de la revue de la littérature était d'obtenir une vue de l'ensemble des concepts théoriques pertinents à l'élaboration du nouveau cadre de référence pour l'évaluation ergonomique en réadaptation/RTW.

Tout d'abord, cinq modèles différents par rapport à leurs éléments représentés dans le système de travail sont comparés. Ensuite, la réflexion théorique découlant de la comparaison entre ces différents modèles et de la détermination de la portée réelle

de l'évaluation ergonomique est présentée. Le chapitre 2 introduit une considération théorique importante : pour réaliser une collaboration d'équipe efficace, les idées et les concepts supportant l'évaluation ergonomique doivent être extrêmement clairs et bien définis pour tous les acteurs impliqués dans la réadaptation, car ceux-ci travaillent vers un objectif commun. Aussi, ils ont tous besoin d'échanger des informations sur de nombreux aspects de la dynamique individu/environnement au cours du processus de RTW (Rice, 1998; Gard & Larsson, 2003). Cette considération a été l'un des principes directeurs dans l'élaboration de notre cadre de référence.

Les chapitres 4 et 5 sont consacrés à l'exploration et à la définition du contenu de l'évaluation ergonomique (phase 1). Le chapitre 4 (étude I) présente, au moyen de 10 cas de LBD, les thématiques interdisciplinaires sur les facteurs environnementaux du travail pertinents à la réadaptation/RTW. Les résultats de cette recherche exploratoire sont destinés à générer une compréhension du système de travail à partir des réunions de groupes interdisciplinaires d'un programme de réadaptation/RTW utilisé au Québec. Les dix cas étudiés se concentrent sur les questions d'environnement de travail qui émergent de ces réunions. Au centre de réadaptation où les analyses ont été réalisées, l'équipe interdisciplinaire se composait d'un coordonnateur clinique, d'un kinésiologue, d'un psychologue, d'un médecin généraliste (ou un médecin orthopédiste), d'un ergothérapeute et d'un ergonome. Le chapitre 4 fournit également un cadre de référence sur la participation interdisciplinaire de l'interface personne-environnement (Figure 4-3). Ce chapitre comporte aussi une discussion sur les aspects réels des situations de RTW sous l'angle d'une équipe interdisciplinaire de réadaptation. Le cadre de référence devrait permettre de mieux comprendre la portée de l'ergonomie ainsi que celle des autres disciplines (ex., l'ergothérapie) impliquées dans la collecte d'information sur les éléments de l'environnement de travail dans un objectif de réadaptation/RTW.

Le chapitre 5 (étude II) présente l'ensemble des variables importantes pour la réadaptation des cas de LBD en se basant sur une comparaison des différents points de vue entre ergonomes au moyen d'un cadre conceptuel (« Work Compatibility Model / WCM ») proposé par Genaidy et al. (2005). La « technique de groupe nominal » a été choisie pour recueillir les opinions de cinq ergonomes travaillant

dans différents centres de réadaptation du Québec. Une fois le consensus dégagé, une analyse déductive a été réalisée en utilisant les principaux éléments décrits dans le WCM. La perspective à la fois intégrée et globale du système homme-au-travail offert par le WCM a notamment mené à une discussion sur le contenu des évaluations ergonomiques. Elle a aussi conduit à une présentation d'un cadre de référence contenant certains facteurs reliés au travail n'ayant reçu jusqu'à maintenant qu'une faible attention de la part des chercheurs du domaine de la réadaptation. Les participants à cette étude ont notamment indiqué que dans la pratique, une très grande attention est accordée à l'évaluation physique ainsi qu'aux nombreuses exigences liées à l'organisation du travail. Plusieurs caractéristiques personnelles des employés sont toutefois évaluées par un autre membre de l'équipe même si celles-ci sont jugées pertinentes à l'évaluation ergonomique. La structure du cadre de référence présenté pourrait ainsi aider les ergonomes oeuvrant dans les programmes de réadaptation/RTW à établir un dialogue plus ouvert au sujet de leurs pratiques avec d'autres professionnels de la réadaptation. Un tel dialogue pourrait contribuer à améliorer le travail des équipes interdisciplinaires impliquées dans la réadaptation en milieu de travail. Enfin, les résultats présentés au chapitre 5 suggèrent que tout cadre d'évaluation ergonomique devrait impérativement s'insérer dans un cadre trans-disciplinaire pour déterminer les solutions les mieux appropriées au contexte des incapacités musculo-squelettiques.

Puisque la recension des écrits existante est principalement axée sur les méthodes d'ergonomie à des fins de prévention primaire, la deuxième phase de cette thèse consistait à identifier celles de ces méthodes qui pourraient être appropriées pour la prévention secondaire et tertiaire des lombalgies. Se basant sur une revue de la littérature pertinente ainsi que des consultations auprès dix ergonomes, le chapitre 6 (étude III) présente les différents aspects de l'applicabilité des méthodes d'ergonomie dans le contexte de la réadaptation/RTW, tout en portant une attention particulière aux méthodes qui ont été recommandées à cet effet. L'applicabilité des méthodes d'ergonomie a été évaluée en fonction de deux aspects: l'utilité pratique des outils (i.e. les caractéristiques des outils en fonction de l'opinion des ergonomes utilisateurs) et des domaines couverts par un ensemble de méthodes pertinentes. Cette étude a permis de soulever les questions suivantes:

1) Est-ce que ces méthodes sont utiles en fonction des caractéristiques jugées importantes par les ergonomes travaillant dans ce domaine?

2) Quels éléments d'un système de travail sont réellement couverts par ces méthodes (i.e. contenu)?

L'objectif était de répondre à ces questions dans une forme qui permettrait aux praticiens de faire un usage plus efficace des outils existants. Puisque le problème de l'utilisation de différents outils en matière de réadaptation n'a guère été exploré dans la littérature, les résultats présentés dans le chapitre 6 fournissent seulement un appui préliminaire à certains outils ayant montré des caractéristiques intéressantes. Globalement, les informations présentées sur l'applicabilité de vingt trois méthodes existantes pour évaluer la situation professionnelle des personnes affectées par une lombalgie (LBD) pourraient aider les ergonomes à améliorer leur stratégie d'évaluation ainsi que leur processus de sélection d'outils d'évaluation.

Les chapitres 4, 5 et 6 ont permis le développement d'un cadre de référence permettant l'évaluation ergonomique du travail pour répondre aux besoins et aux difficultés exprimées par les ergonomes travaillant à la réadaptation / RTW des travailleurs atteints d'une incapacité chronique liée aux lombalgies (chapitre 7). Les données empiriques et théoriques ont été examinées afin d'élaborer un cadre de référence pouvant supporter un certain nombre de décisions lors de la détermination du «quoi» et du «comment» évaluer la situation professionnelle des personnes présentant une lombalgie (LBD). Dans cette perspective, le cadre de référence présenté ici n'est pas seulement un outil pratique d'aide à la décision, mais aussi un outil permettant d'amener les ergonomes vers une pratique fondée sur des données probantes.

Le chapitre 7 décrit en détail, le développement du cadre de référence. Il propose de formaliser le processus d'évaluation afin d'aider les ergonomes à évaluer plus efficacement les réalités du travail. Ce cadre de référence fait une utilisation efficace des outils existants à l'intérieur d'un plan d'action destiné à l'évaluation ergonomique (les principales informations sur les méthodes recommandées de l'étude III ont été intégrées dans ce cadre). Au cours de ses phases de développement (i.e. phase 1 et 2), la participation active des principaux utilisateurs

au cadre de référence (i.e. les ergonomes travaillant dans les programmes actuels de réadaptation) a été soigneusement examinée. Dans l'étude II, le consensus d'un groupe de cinq ergonomes a été obtenu sur les éléments de travail pertinents à la pratique de l'ergonomie. Dans l'étude III, les différents points de vue de dix ergonomes travaillant dans ce domaine ont été recueillis à l'aide d'un questionnaire en vue de cerner l'utilisation réelle des méthodes ainsi que le mode de sélection des critères dans un contexte de réadaptation/RTW. Dans ces deux études, seul les ergonomes possédant une expérience spécifique dans le domaine de la réadaptation/RTW de travailleurs souffrant d'incapacités (i.e. ceux dont les absences au travail étaient associées à des troubles musculo-squelettiques) ont été sélectionnés. Cette précaution permettait ainsi de s'assurer de l'engagement de ceux qui deviendront plus tard les principaux bénéficiaires des conclusions de cette recherche.

Non seulement ce cadre de référence a t-il été conçu pour prendre en compte la réalité des différentes pratiques en ergonomie, mais il a aussi été élaboré pour tenir compte d'un modèle de travail d'équipe interdisciplinaire. De récentes études sur les pratiques de réadaptation au travail ont en effet suggéré que cette approche devrait être utilisée pour promouvoir une communication et une planification inter-fonctionnelle plus efficaces entre les différents partenaires. À ce titre, le cadre de référence décrit comment promouvoir les activités d'échange interdisciplinaire en mettant en lumière l'idée que les ergonomes devraient se concentrer sur des informations utiles qu'ils peuvent directement fournir à l'équipe de réadaptation (selon les conclusions de l'étude I).

En résumé, le chapitre 7 présente un cadre de référence sous la forme d'un algorithme (i.e. séquence d'étapes) qui propose à l'ergonome un plan d'action basé sur des données empiriques et des connaissances théoriques concernant les pratiques actuelles de réadaptation. L'idée à l'origine de ce cadre de référence était de créer une structure d'évaluation bien planifiée de l'environnement de travail qui pourrait: 1) empêcher les ergonomes de prendre une perspective réductionniste du problème de lombalgie (LBD), et 2) faciliter un dialogue ouvert avec les autres professionnels de la réadaptation en termes d'échange de données sur les aspects reliés au système de travail. Une telle ouverture de dialogue est elle-même

réellement nécessaire pour permettre des décisions éclairées au sujet des interventions en milieu de travail.

Finalement, le chapitre 8 résume et analyse les résultats présentés dans le chapitre 7 à la lumière de l'objectif initial de recherche. Le chapitre 8 présente aussi des suggestions sur l'orientation générale que devraient prendre les recherches futures sur ce sujet, et termine par la conclusion générale de la thèse. En bref le cadre de référence que nous présentons permet non seulement une approche formalisée qui aide les ergonomes à identifier les contraintes reliées au travail qui empêchent les personnes affectées par une lombalgie (LBD) de reprendre leur fonction, mais aussi la promotion de la planification inter-fonctionnelle à l'intérieur d'un modèle de travail d'équipe interdisciplinaire.

Compte tenu de la nécessité d'une procédure plus formelle pour répondre au besoin d'échange d'information multidisciplinaire, le cadre de référence pourrait ainsi contribuer à promouvoir les meilleures pratiques d'ergonomie dans le domaine de la réadaptation. L'utilité du cadre de référence comme atout de collaboration nécessite néanmoins des recherches supplémentaires.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACE	Association of Canadian Ergonomists
AET	Arbeitswissenschaftliche Erhebungsverfahren zur Tätigkeitsanalyse
ACGIG (TLV)	American Conference of Governmental Industrial Hygienists (Threshold Limit Value)
DOT	Dictionary of Occupational Titles
FCE	Functional Capacity Evaluation
F-JAS	Fleishman Job Analysis Survey
ICF	International Classification of Function
ILO	International Labour Office
ISO	International Organization for Standardization
JCQ	Job Content Questionnaire
JDA	Job Demands Analysis
JDQ	Job Description Questionnaire
LBD	Low Back Disability
LMM	Lumbar Motion Monitor
MFA	Rodgers Muscle Fatigue Assessment
MSDs	MusculoSkeletal Disorders
NASA-TLX	NASA- Task Load indeX
NRC	National Research Council

CHAPTER 1 : INTRODUCTION

1.1 Statement of the problem

The consequences of work incapacity associated with back pain are enormous to society when considering human suffering, high medical and compensation costs, and loss of productivity in the workplace. An industrialized country can spend more than 1% of its gross national product dealing with the indirect and direct costs of back pain alone (van Tulder et al., 1995). Back pain have been cited as the most expensive health care problem in the 30-50 year age group and are one of the leading causes of disability in adults less than 45 years of age (Kelsey & White, 1980; Ricci et al., 2006). Indeed, among industrial populations back pain is second only to the common cold as the main cause of missed workdays (Praemer et al., 1992). Fortunately, in most cases this pain subsides by itself during the first four weeks – with or without medical treatment. The main preoccupation, therefore, is with a few cases in which prolonged work disability can occur. In Canada, it is estimated that LBD costs the Canadian workforce and business community more than $10 billion per year (van Tulder et al., 1995). Most of these costs are related to compensation payments and high health care expenditures (Hashemi et al., 1997; Coyte et al., 1998; Joslyn, 1999). In the province of Quebec (Canada) and in many other parts of the industrialized world, it is estimated that the 5-9% of workers in long-term sickness absence related to back pain are the ones generating the highest financial expenses (i.e. accounting for over 70% of the total costs for occupational back injuries) (Abenhaim & Suissa, 1987; Chibnall et al., 2000).

Beyond the economic burden, occupational LBD affects the well-being and quality of life of workers and their families (Feuerstein et al., 2001; Krause et al., 2001a; Franche & Krause, 2002). In dealing with this serious socio-economic concern, governments and non-governments organizations – mainly from developed countries – have invested a considerable amount of human and financial resources to develop strategies that can reduce the financial and human costs of low back disabilities (Adams et al, 2006; Tompa et al., 2008). All this effort is well-justified as this problem is no simple matter. Different stakeholders have recognized the level of

complexity and difficulties in dealing with this phenomenon (Frank et al., 1998; Jette & Badley, 2000; Westmorland et al., 2002; Baril et al., 2003). Today there is consensus among the scientific community recognizing LBD as a multifaceted problem in which a confluence of social, behavioral, psychological, medical, legislative, economical and work-related factors impact both its status and duration (Feuerstein et al., 2001; Loisel et al., 2001a; Truchon, 2001; Franche & Krause, 2002; Linton et al., 2002).

Because treating the medical aspect of back pain alone is proven to be ineffective, prevention and optimum management disability strategies have been proposed around the world by different stakeholders (Hlobil et al., 2005a, Snook, 2005; Sullivan et al., 2005; Tompa et al., 2008). One very promising approach is the new disability management model adopted by traditional rehabilitation facilities (Hochstenbach, 2000). The service they provide is called work rehabilitation program (also referred as return-to-work/RTW programs) because RTW is part of recovery and the interventions are carried-out in the real work environment (Durand et al., 2007; Williams et al., 2007). These evidence-based programs utilize a proactive disability management model that promotes close collaboration among all stakeholders involved in the issue (namely insurance advocates, workplace players, health care professionals and the injured worker) (Friesen et al., 2001; Westmorland & Buys, 2004; Franche et al., 2005a). These programs differ from traditional medical rehabilitation programs often carried out far from the workplace and which emphasize functional restoration or worker-worksite matches based on a medical model rather than a disability one (Loisel et al., 2001a; Briand et al., 2007).

They offer early RTW because foremost maintaining a link with work and workplace is recognized as beneficial for workers with back pain. The International Labour Office (2008) recently has emphasized the meaning of work in the lives of people, regardless of whether they have a medical condition or not: "work is not just an economic issue, it provides a means to prove one's worth and ability, gain self-confidence and self-esteem, and participate in the life of the community" (International Labour Office [ILO], 2008). Thus, these newly developed programs offer the necessary RTW interventions – preferably at an early phase of the disability cycle – taking into account the individual's circumstances and the social

and physical environments of the workplace (Durand & Loisel, 2001a; Franche et al., 2005a; Williams et al., 2007). So far studies of the effectiveness of these programs demonstrate positive outcomes provided that they include the following features: 1) an interdisciplinary team approach or a well-coordinated case management (Loisel & Durand, 2003; Ozguler et al., 2004); 2) adopt workplace-based interventions tailored to each individual (Yassi et al., 1995; Frank et al., 1998; Staal et al., 2002; Loisel & Durand, 2003); 3) promote reassurance messages regarding pain management behavior and work (Indahl et al., 1995; Loisel & Durand, 2003); and 4) encourage partnerships between stakeholders (Frank et al., 1998; Baril et al., 2003; Loisel & Durand, 2003). All of these features are increasingly being adopted by many traditional rehabilitation programs and are emerging as a central focus of rehabilitation medicine literature. More recently, the importance of effective inter-organizational communication and the role that interdisciplinary teams play on this aspect have been recognized as critical elements for achieving successful work reintegration outcomes (Pransky et al., 2004; Loisel et al., 2005a).

Research in this area is still in early stages of development and there are many questions that remain unanswered, especially when it comes to workplace interventions designed by interdisciplinary teams (Waddell & Burton, 2005; Briand et al., 2007). Ergonomics as an applied discipline that can provide hands-on workplace-based solutions for workers with back problems has increasingly been integrated into this rehabilitation milieu with promising results. Up until now many studies have shown positive outcomes of ergonomic practices for secondary and tertiary prevention of musculoskeletal disabilities such as higher speed rate of the RTW process, costs reductions and high level of worker's satisfaction (Loisel et al., 2001b; Anema et al., 2003; Franche et al., 2005a; Ouellette et al., 2007). As a result, more and more contemporary rehabilitation/RTW programs are including an ergonomics component in their approach (Loisel et al., 2001b; Anema et al., 2004; Franche et al., 2005b; Ouellette et al., 2007).

This is not a recent trend; however, research in this area is in its very early stages of development. In the past, several authors have presented the importance of including an ergonomic component in disability management for workers with back

pain (Kornblau, 1989; Halpern, 1992; Mital, 1995; Pennathur et al., 1996). However, ergonomic practice frameworks specifically developed for contemporary rehabilitation/RTW programs have yet to be fully defined (Staal et al., 2002). In fact, it is difficult for different stakeholders, including employers, insurers and rehabilitation professionals, to identify from the existing literature which ergonomic measures and methodologies are employed in these newly developed RTW programs (Stall et al., 2002; Durand et al., 2007; Ouellette et al., 2007). Staal et al (2002) reviewed the literature on RTW interventions for low back pain cases and noted that none of the studies provided a description of the components of ergonomic measures adopted by their RTW programs, nor did they describe the process, criteria and procedures used for ergonomic analyses.

A clear understanding of the ergonomic work evaluation process is not only advantageous for the implementation plan of workplace based interventions, but is also an asset for effective teamwork in rehabilitation and inter-organizational communication (Halpern, 1992; Hamrick, 1999; Feuerstein et al., 2001; Waddell & Burton, 2001; Durand et al., 2003). The more defined and standardized the evaluation framework used by ergonomists, the higher the chance that they can identify all the elements that may hinder or facilitate a human-at-work system balance. Promoting a system balance is critical to generate a supportive environment for each individual to work at his/her most safe and effective levels. In addition, the use of a standardized evaluation model is an important starting point for rehabilitation ergonomists to conduct evidence-based practices. Therefore, empirical studies examining ergonomists' evaluation processes and practice frameworks used in work rehabilitation programs are deemed necessary (Armstrong et al., 2001).

1.2 Main context and scope

The figure below (Figure 1-1) seeks to place this dissertation in the broader context of disability management and prevention systems model (Loisel et al., 2001a). It shows the main elements present in each system in an organized manner (i.e. the compensation, personal, healthcare and workplace systems). In the new disability paradigm presented by Loisel et al. (2001a), these elements are interrelated and

should be viewed as such. For illustration purpose, the workplace system was highlighted to call attention to the scope of this dissertation and to the fact that it focuses on only one element of the disability paradigm. It's very important, however, to keep a comprehensive view of the disability problem in order to situate the boundaries of this research.

It is also important to situate this dissertation in relation to the broader context of work rehabilitation. Typically this field covers the following three areas: 1) all activities aimed at making an unemployed worker with a work-related injury/disorder able to RTW; 2) all activities aimed at redirecting a worker with an injury/disorder into another line of work if he/she is unable to return to his/her previous job; and 3) all activities aimed at helping a worker with an injury/disorder return to the his/her previous employer (i.e. to the exact the same job, to temporary work accommodation(s), or to permanent work modification(s)). The provision of vocational rehabilitation requires a different research focus due to the differentiated needs and objectives of rehabilitation ergonomics (e.g. enlargement of job opportunities, selective placement of a person with specified impairments and comparison of training schemes with real job demands). Instead, this dissertation focuses on ergonomics for the redesign of existing jobs and/or documentation of work situations as part of a disability management strategy for individuals that have a job available to return to. Overall, this research is designed to study a new phenomenon: the practice of rehabilitation ergonomics according to the needs of contemporary work rehabilitation programs which have workplace-based interventions as their primary focus (Briand et al., 2007; Durand et al., 2007).

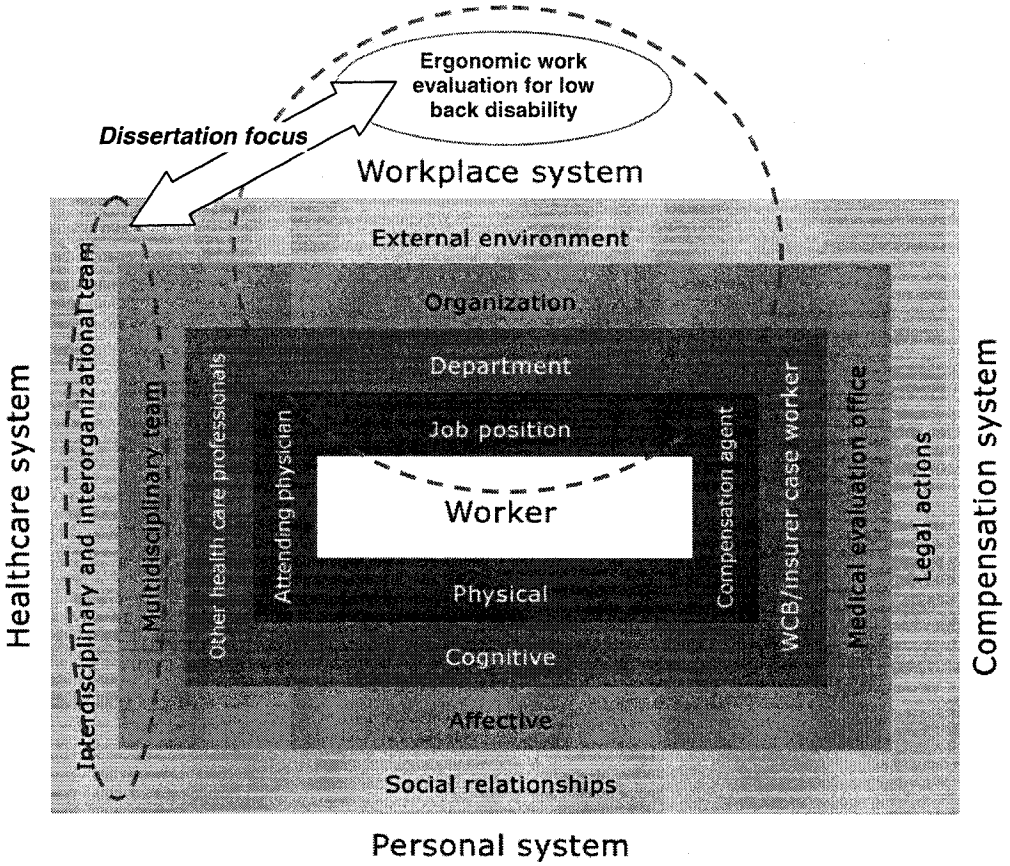

Figure 1-1: Dissertation's main focus in relation to a comprehensive ecological model for disability prevention/management (adapted from Loisel et al., 2001a)

It is also important to specify that the target population addressed herein is workers who present work incapacity associated with back pain (in sub-acute or chronic phases). Specific occupational guidelines have been developed for this population such as the one proposed by Wadell & Burton (2001). According to these authors, any worker with back pain who is experiencing difficulty returning to normal occupational duties at approximately 4 to 12 weeks should be enrolled in an active and comprehensive rehabilitation program which includes a strong emphasis on RTW (Waddell & Burton, 2001; Waddell, 2006). This recommendation is based on substantial scientific evidence showing that: 1) the longer a person with back pain is away from his/her job the less likely that disability and pain status will change; and 2) when jobs are accommodating and safe, the benefits of work for a person with

back pain outweigh the harmful effects of prolonged sickness absence (Waddell et al., 2003).

1.3 Purpose of the dissertation

The primary objective of this dissertation is to describe the practice and contribution of ergonomics to the rehabilitation/RTW of LBD cases in terms of the evaluation content, process and tools utilized. This research had a particular focus on studying current ergonomic practices vis-à-vis the perspectives of ergonomists working in rehabilitation/RTW programs situated in Quebec, Canada. Because of the bilingual and bi-cultural location, the group investigated offered an understanding of rehabilitation ergonomic practices from ergonomists that have French ergonomics training and/or human factors training.

To accomplish the main objective three studies were conducted and they have addressed the following research questions:

Study I:

- What are the work environment issues as discussed by an interdisciplinary team engaged in the rehabilitation/RTW process of individuals presenting LBD?

- How can these variables be classified?

Study II:

- From the list of work factors identified in Study I, which ones are considered important for the work evaluation of LBD cases according to ergonomists working in rehabilitation/RTW programs? In which context are these factors considered?

- Do these factors match with the elements of a conceptual model that guides a work system evaluation?

Study III:

- Which ergonomic methods are recommended and/or designed for use in rehabilitation/RTW of LBD?

- Are these methods used by practitioners? Which are the important features for tool selection in this field according to ergonomists?

- Are these methods applicable to rehabilitation according to their features and the content covered?

The secondary objective of this dissertation was to develop a preliminary version of an ergonomic evaluation framework by using the scientific and practical knowledge gathered herein. This framework represents a guided process for helping ergonomists optimize their work evaluations for LBD cases utilizing a team-based problem-solving approach often used by contemporary rehabilitation/RTW programs.

1.4 Relevance of the dissertation

Work participation for those with subacute and chronic back pain is a multifaceted challenge and it requires a comprehensive approach in order to effectively address emotional-behavioral, environmental and socio-economic factors that interplay with worker's health and absenteeism. An interdisciplinary team model informed by adherence to rigorous standards of rehabilitation practices (such as effective communication with stakeholders) is the best approach to deliver such a multifaceted health care package. This dissertation takes into account the inherent complexity of the problem and the necessary interdisciplinary teamwork model needed to address it. The main contribution of this dissertation is to identify the gaps between our scientific knowledge and current rehabilitation ergonomic practices. In the absence of knowledge in this emerging field, this information is a starting point for promoting best practices in rehabilitation ergonomics and utilization of evidence-based principles.

In an effort of filling the identified gaps that exist between research and practice, this dissertation aims to go one step further to propose an ergonomic evaluation framework based on the hypothesis that a formalized approach to assess the work situation of persons with LBD will help ergonomists to better perform their duties and facilitate more effective interdisciplinary and inter-organization collaborations.

1.5 Outline of the dissertation

In addition to answering the research questions listed above, a literature review on the ergonomic work evaluation process and its scope was performed and it is presented in the next Chapter (Chapter 2). This review presents the cumulative scientific knowledge and current research gaps in the field of rehabilitation ergonomics for RTW programs, which establishes the theoretical foundation for the framework development. Chapter 3 presents an overview of this dissertation and its main phases in relation to the research objectives.

Chapter 4 corresponds to Study I and it focuses on the interdisciplinary discussion of work environment issues as a starting point to define the pertinent content for workplace evaluations. Chapter 5 corresponds to Study II and it further defines the ergonomic evaluation content and identifies key challenges for conducting such evaluations from the point of view of ergonomists working in rehabilitation/RTW programs. Chapter 6 corresponds to Study III and it investigates the applicability and usage of tools for the rehabilitation/RTW of individuals presenting LBD. The views of ergonomists working in this field were collected in this stage as well.

In order to describe such a new phenomenon, i.e. the practice of ergonomics as part of work rehabilitation programs, it was necessary to utilize a qualitative research approach. All three studies present mainly a descriptive research perspective, however Studies I and II were also exploratory in the manner the questions were raised and answered, i.e. they describe what and how in relation to the object of research and define new research avenues. Study III, on the other hand, presents an evaluative characteristic. Chapters 4, 5 and 6 were originally written as separate articles for publication in scientific journals.

Chapter 7 presents a consolidation of the results from Studies I, II and III in order to describe the development of the new ergonomic evaluation framework for the RTW of LBD cases. Key findings from the literature review presented in Chapter 2 were also considered in the framework development. Lastly, Chapter 8 provides a general discussion on the findings and main conclusions of this dissertation.

CHAPTER 2: LITERATURE REVIEW

In this Chapter, the pertinent literature on ergonomic work evaluation in the context of disability management is presented. For organizational purposes, this literature review was divided into two main sections: the studies concerning the ergonomic evaluation process and the studies concerning the scope of this evaluation.

2.1 The scope of the ergonomic evaluation: what to evaluate?

The first issue ergonomists face upon identifying that there is a need for a work evaluation is determining what should be evaluated. This question has no easy answer when considering a multi-faceted LBD problem and all the interacting factors associated with it. The literature related to work-related factors impacting low back disability (LBD) duration and the return-to-work (RTW) process (i.e., delayed recovery factors, RTW predictors, obstacles, etc.) is vast (Turner et al., 2000; Truchon, 2001; van Duijn et al., 2004; Soucy et al., 2006). The best approach to understand this information is to examine the current literature on disability and ergonomics models. A comparative analysis of these models can provide a generic theoretical foundation for understanding the scope of ergonomic evaluation. Before presenting the referred literature, it is necessary to describe the existing knowledge on the overall aims of ergonomic evaluations in the context of rehabilitation/RTW.

2.1.1 The objectives of ergonomics in rehabilitation

Research on the scope of ergonomics for contemporary rehabilitation/RTW programs is in its early stages of development. Until further advancement is reached, the available knowledge on the overall aims of ergonomics with regards to a work rehabilitation context should be considered. There are several studies specifically dedicated to specifying the objectives of job evaluations for individuals with musculoskeletal disorders (Halpern, 1994; Johnson & Delaney, 1998; Kuijer et al., 2006a). The aims of these evaluations are usually determined on a case-by-case basis, and they are context-sensitive, e.g., the analysis of manual handling activities for an individual with back pain working in a supermarket, or the study of the mental and physical workload of a nurse with a neck injury. Chapter 6 (Study

III) is dedicated to presenting a detailed literature review of the existing formal methods (such as questionnaires, observational methods, interviews, etc.), which are usually used as part of the ergonomic evaluation plan and rehabilitation process.

A unifying definition of ergonomics that can be used across different practices has been proposed by Dempsey et al. (2000); more specifically, it is "the design and engineering of human machine systems for the purpose of enhancing human performance." While optimizing human performance is the ultimate objective in ergonomics, each determinant of optimum human performance, such as safety, health, quality, well-being and productivity, is an important part of this objective (Dempsey et al., 2000). It is apparent that determinants directly related to the worker (e.g., health, comfort, etc.) are influenced by those operating at the organization level (e.g., productivity and quality) and vice-versa. The figure below is a classical representation of the aims of work system ergonomics demonstrated in such a way (Figure 2-1) (Wilson & Corlett, 1995).

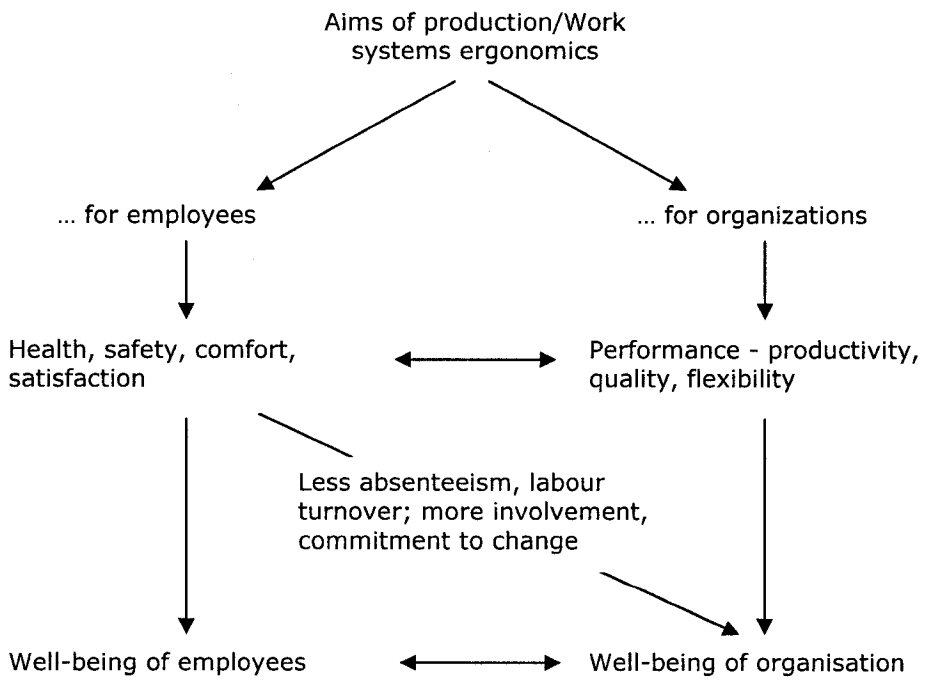

Figure 2-1: Schematic representation of the suggested aims for work system ergonomics (adapted from Wilson & Corlett, 1995).

The two interdependent objectives of ergonomists are represented as benefiting both the workers and the organizations. There have been insightful debates in the ergonomic literature on the boundaries between what ergonomists are doing in practice and what they should be doing (according to theory) in terms of accomplishing both aims (Norman & Wells, 2000; Ahasan & Imbeau, 2003; Dul & Neumann, 2005; Falzon, 2005; Falzon & Mas, 2007). According to Wilson and Corlett (1995), despite the ethical and practical dilemmas when aiming for both, ergonomists should always commit to both individual jobholders and the employing organization. Theoretically, this has been the most accepted approach, and many ergonomics methods used in practice have utilized this principle as their main foundation (Wilson & Corlett, 1995).

Although the practical barriers for implementing this ergonomic approach are recognized, several authors have suggested that this is the necessary path to take for the application of ergonomics in rehabilitation (Rice, 1998; Khalil et al., 1999; Kumar, 2000b). These twin-objectives go hand-in-hand with the main aim of evidence-based rehabilitation/RTW programs, i.e., to promote sustainable workplace-based RTW interventions in close partnership and coordination with workplace actors' needs and interests (Briand et al., 2007). Rice (1998) suggested a systems-based approach for rehabilitation ergonomics and specified the role of the ergonomist not only in evaluating performance and subjective preferences, but also as the evaluator of the impact of design changes on the organization as a whole. Notably, the ergonomist is in an ideal position to identify organizational outcomes (e.g., quality, productivity and innovation) and any of their consequences to the individual performance (Falzon & Mas, 2007). Up until now, however, no studies can be found on whether ergonomists working in rehabilitation/RTW programs are measuring the impact of their interventions on organizational outcomes.

Alternatively, some RTW programs have adopted participative ergonomic methods, which may provide changes to work or work organization by involving the workers and enabling them to participate in the job design or re-design processes (Loisel et al., 2001b; Anema et al., 2003). One well-recognized advantage of this methodology is its systemic effect beyond its original focus, usually impacting the organizational performance (Brown, 2005). The studies found on the participatory

approach for RTW programs, however, did not mention if any organization-related outcomes were measured (Loisel et al., 2001b; Anema et al., 2003). Nevertheless, both studies demonstrated the global effectiveness of the ergonomics interventions according to RTW outcomes.

Genaidy et al. (2007a) have combined an extensive body of knowledge on ergonomics theories and psychology studies on human performance and highlighted the need to consider organizational outputs and companies' sustainable growth whenever the aim is the optimization of an individual worker wellness (i.e., work conditions, health and safety). They have developed a model, called the Work Compatibility Improvement Framework (WCIF), which is based on an integrated perspective of the human-at-work system and has been implemented in a manufacturing environment (Genaidy et al., 2007a; 2007b). The proposed perspective for optimizing performance from this innovative angle might be the future direction of research, aiming to evaluate the impact of ergonomics interventions on the overall system performance by considering performance determinants for the well-being of individuals and organizations in an integrated manner.

Hence, the aforementioned literature suggests that ergonomists working in rehabilitation should consider the twin-aims of ergonomics. It is unknown, however, the practical means through which the ergonomists will be able to incorporate both of these goals in their ergonomic work evaluation process for rehabilitation/RTW purposes.

2.1.2 Disability and ergonomics models for musculoskeletal problems

A large number of models from disciplinary and multidisciplinary perspectives have been proposed for successful RTW of workers with musculoskeletal disorders (Helm et al., 1999; Norman & Wells, 2000; Friesen et al., 2001; Janssen et al., 2003; Tate & Pledger, 2003; Faucett, 2005). One central aspect of current model development in the field of work disability is the recognition of the role of work above and beyond the recognition of individual functional limitations (Jette & Badley, 2000;

Hochstenbach, 2002). In fact, social and economical aspects cannot be viewed outside the scope of the disability problem.

The consideration of these different models is important for better understanding the scope of ergonomics in rehabilitation. A recent literature review provided analytical comparison of many of the existing RTW models (Schultz et al., 2007). These included the biopsychosocial model, the ecological case management model, the Institute of Medicine model of disability, and the International Classification of Functioning, Disability and Health (ICF) (Schultz et al., 2007). From this referred review many questions related to current occupational rehabilitation practices and the state-of-art knowledge in work disability prevention were raised. A conclusion from this review was that no single model truly accounts for the temporal and multidimensional aspects of occupational disability in a truly transdisciplinary way (Schultz et al., 2007). Another problem with current RTW models is their description of the elements of the work system and their related outcomes (Faucett, 2005; Schultz et al., 2007). This is a particular important subject for ergonomists working in rehabilitation/RTW programs and should be explored further.

Both in French and English ergonomics, many models and theories exist to guide the ergonomists' rational for addressing musculoskeletal disorders (Armstrong et al., 1993; Guerin et al., 1997; Falzon, 2005; Faucett, 2005), and many excellent reviews are also available (Westgaard & Winkel, 1997; Karsh et al., 2001, Tuncel et al., 2008). Although most of them might prove important in framing possible paths for practice, their generic views cannot provide a sufficient level of detail on the work system components, or describe the interactions between the complex web of variables and different individual and work outcomes.

Still, it is necessary to take into consideration that these models offer strong scientific knowledge that can lead to further advancements in the field. Accordingly, a comparative review of existing models is presented. The focus was to identify and compare models which offer descriptive detail on the work system considering the main objective of the present research. It is important to mention that given how relatively new the application of ergonomics in disability management is, it was

necessary to consider the existing literature specific on RTW models as well as models for prevention of musculoskeletal disorders in general.

Notwithstanding, five models should be mentioned here, keeping in mind that they were identified on the basis of the level of information they provide on the work system as to be able to inform ergonomists on the aspects of work that could impact musculoskeletal health and work performance in general. The models identified were 1) the work compatibility model (WCM) – also referred to as the work compatibility improvement framework (WCIF) – which mainly characterizes the work factors impacting musculoskeletal and stress outcomes at the job/individual level (Genaidy et al., 2005; 2007a; 2007b); 2) a model that integrates psychosocial factors into other well-known musculoskeletal disorders models (Faucett, 2005); 3) another integrated model that targets evidence-based exposures (Karsh, 2006); 4) the expanded version of the ICF (Heerkens et al., 2004); and 5) an activity-centred model based on an important French ergonomics concept called zone of adaptability ('marge de manoeuvre' in French (Vézina, 2001). The relevance of these models to the present research is not only that they describe with a certain level of detail the work environment factors, but also they represent important theoretical advancement for incorporating many important theories and taxonomies as listed in Table 2-1. The reader can refer to their respective publications for details on their development and applicability.

Table 2-1 shows the basic information regarding the aforementioned models. Because these models come in such diverse forms, it was important to present their classification of the work system elements. All of them cover most of the elements of an inclusive work system (i.e. individual capacity, human-task interactions, social elements, organizational elements, physical workload, mental workload and environmental elements), although with a different emphasis on each element (Shoaf et al., 1998). For instance, in the model of Faucet (2005), special attention is placed on the relationship of management systems (i.e., culture, resources, decision-making, etc.) and how they can impact worker performance and productivity. This model takes into account the current evidence on organizational risk factors associated with musculoskeletal disorders (Faucet, 2005). In fact, all models take into account awareness of work-related risk factors based on the

scientific evidence. Karsh's model, in particular, considers potential exposures, dose-response relationships and capacity issues based on empirical studies, yielding relevant recommendations for intervention research (Karsh, 2006). The expanded ICF-scheme is the only model which considers external factors within and outside the work environment (i.e., home environment) that influence work participation according to barriers and obstacles identified in the literature (Heerkens et al., 2004).

The WCM has been validated in a small manufacturing company and in a hospital setting (Genaidy et al., 2005; Genaidy et al., 2007b). The other four models are in their early stages of development, and further validity studies are necessary. Worth mentioning here is the recent application of the model proposed by Vézina (2001) in RTW programs. In general, the model covers all components of the work system from a different point of view, i.e., one in which the work activity is the central element structuring a person's work situation (Daniellou, 2005). The concept of "marge de manoeuvre" is essential to this model. Succinctly, it refers to the regulating mechanism a person has in order to meet the demands of his/her activity in various levels (i.e., physical, mental or social) (Vézina, 2001). A recent study applied the dimensions of this concept in a progressive RTW program (Durand et al., 2008). Their findings suggest, among other things, that it is essential to analyze the activity while taking into consideration the whole person-environment interface (Durand et al., 2008). Interestingly, a similar conclusion was obtained by a very different study that aimed to examine the WCM in manufacturing with respect to the evaluation of working conditions impacting musculoskeletal/stress outcome measures (Genaidy et al., 2008). They concluded that "it is essential to evaluate the various domains of worker-work environment interface to uncover the root causes which tend to sub-optimize the physical/cognitive/emotional health of the workforce."

Table 2-1: Comprehensive person-environment models for musculoskeletal disorders: description, related theories and classification of their work system components

Authors	Main description	Related theories and taxonomies	Classification of the work system elements
Genaidy et al. (2005) & (2007a)	A comprehensive model that explains the interaction between worker-work environment in terms of energy expenditure and energy replenishment	Adaptative control model Balance Theory Demand-Control model Effort-reward imbalance Job characteristics theory Motivation-Hygiene theory Person-environment fit NASA-TLX[1] AET PAQ	Acting compatibility (demands or energizers) - Physical task content - Mental task content - Physical environment - Organizational environment - Social/communication environment - Technological environment - Economic Growth - Individual growth Experienced compatibility (demands or energizers) - Effort - Perceived risk/benefit - Performance - Psychological impact - Personal characteristics
Karsh (2006)	An integrated model that shows many potential exposures and their relationships for targeting interventions based on empirical data.	Armstrong et al. (1993) Hagberg et al. (1995) Sauter & Swanson (1996) Feuerstein (1996) Kumar (2001) NRC model (2001)	Workplace factors - Social/cultural context: safety climate; organ. culture & political climate - Work organization: nature of work; work/rest cycle; management; supervision & teamwork - Environment: temperature; noise & lighting - Psychological work demands: job control; support; ambiguity & uncertainty Individual factors - Physical capacity - Psychological capacity - Genetics - Coping - Aging - Gender
Faucett (2005)	An integrated model which considers various approaches, named: organizational design, sociotechnical systems and macro-ergonomics.	Balance Theory Demand-Control model UCSF symptom management model NRC model (2001) Feuerstein (1996) Sauter & Swanson (1996) Kasl & Amick (1996) Melin & Lundberg (1997) Shoaf et al. (2000)	External factors - Management systems: Culture, resources, workforce, decision-making, communications & operations - Work environment: Functional, physical, temporal & interpersonal - Work Barriers Individual Factors - Worker perceptions - Worker strain & recovery

Table 2-1: Comprehensive person-environment models for musculoskeletal disorders: description, related theories and classification of their work system components (continue and end)

Heerkens et al. (2004)	A model that describes the work-related factors influencing work participation and health of workers.	ICF (2001) van der Beek (1994)	External factors - Work-related factors (micro, meso and macro levels): terms of employment, social relationships, task contents, working conditions[2], mental and physical load - Not work-related factors: mental and physical load, home environment, social support, etc. Personal Factors - Personal carrying capacity: physical and psychosocial; - Other personal factors: work-related and general personal factors
Vézina (2001)	An activity-centered model of MSDs, which uses the concept of 'marge de manouvre' with strong emphasis on the identification of risk factors and their determinants.	Guérin et al. (1997) Franchi (1997) Sauter & Swanson (1996)	Factors surrounding the person-activity relation - Production requirements: quality/quantity & guidelines/procedures - Conditions/means offered by the company: physical means, characteristic of the tools, work organization & social structures - Expectations of the different people: co-workers, clients, etc. Factors that are part of the person-activity relation - Physical: Energy expenditure & musculoskeletal hyperloading - Mental: information gathering/processing & planning/ management - Social: communication & mutual assistance - Individual factors: experience, training, physical and psychological characteristics, age, gender

Notes:

1. For all the abbreviations on this table, please refer to list of acronyms and abbreviations of this dissertation on page xxviii and xxix.

2. The authors refer to working conditions as the aspects of the physical environment (e.g., noise, vibrations etc.). In the ergonomics literature, the preferable term is physical environment.

In terms of how each model distinguishes its main focus of analysis – i.e., whether at the individual, the job, the process, the function or the organization level – no major difference can be seen between them, as shown in the column 'classification of the work system elements' (Table 2-1).

The analogy that can be made is that in each model there are two major focuses, the internal and external elements to the person; however, they have described these two elements with different terminology and perspectives. The WCM in particular, according to its developers, keeps its focus on the analysis at the individual/job level; however, each work factor can be explained in relation to the entire system performance (i.e., the individual, the job, the process, the function and the organization levels), which makes this model the most comprehensive of all (Genaidy et al., 2007a). Furthermore, this model uses the well-defined concept of work compatibility and, accordingly, divides work factors into acting factors (i.e., imposed by the environment) and experienced factors (i.e., perceived by the worker). As explained by Karwowski (2000), although 'compatibility' is a term not fully recognized in the ergonomics literature, this concept is essential to ergonomics as a practical discipline, as it orients the documentation of work requirements beyond a theoretical construct towards a more practical level (Karwowski, 2000).

It is also important to mention that the factors in these models generally correspond to different outcomes related to workers' performance and musculoskeletal stress, such as job satisfaction, physical and psychological strain, symptoms, etc. It is difficult to capture, however, how each model accounts for individual variations when considering these outcomes. In work disability prevention, this seems to be a very important consideration (Shaw et al., 2002). Nevertheless, some differences are worth noting between outcome measures of these models.

The model of Faucett (2005) presents several generic musculoskeletal outcomes, such as worker's symptoms, disability and perception; meanwhile, the model of Karsh (2006) shows more details on the relationship between different exposures and internal load responses. This model and the one proposed by Heerkens et al. (2004) do not present any specific outcomes related to the organization's performance. All three of the other models consider productivity as an outcome. In

particular, the WCM takes a step further in this regard by accounting not only for the company's production system but also striving for the company's sustainable growth. In fact, the WCM process is structured on the Six Sigma management strategy phases (Genaidy et al., 2007a), a business management approach that strives quality management and business excellence commensurate with a competitive global economy (Pzidek, 2003).

While the importance of the aforementioned models is recognized, it is clear from the comparison made that there is a need for ergonomic practice models more specifically tailored to occupational disability. This need becomes more evident when considering the possible legal implications of any workplace evaluation for a person uniquely affected by work disability (Kornblau, 1998). On the one hand disability specific models such as the ICF, lack practical information that can guide ergonomists in the work evaluation process, while on the other hand more specific work system models such as the WCF, were not developed to account for the disability status. This lack of ergonomic practice models in disability management highlights the fact that up until now this practice has been essentially driven by practice-based evidence. From a theoretical and methodological standpoint it is necessary to bring this practice closer to a more evidence-based approach. It is also critical that a common agreement exists in terms of the work environment framework that ergonomists should use in contemporary rehabilitation programs in order to move from a practice-based status to an evidence-based practice (Sackett et al 1996; Rosenblum, 2006).

2.2 The ergonomics evaluation process: how to evaluate?

In addition to identifying the theoretical foundation, the scope and the main objectives for an ergonomic evaluation, it is necessary to understand the decision-making process involved to accomplish this task. In simple terms, the process is a series of actions directed toward a specific aim (American Heritage® Dictionary [AHD], 2003). In the case of ergonomic work evaluation for rehabilitation/RTW programs, these actions can be influenced by 1) the issues pertinent to the evaluator, such as objectivity, training, experience, and qualifications; and 2) the

steps taken during the evaluation process with regards to the rehabilitation interface, i.e., the point at which data is aggregated in rehabilitation.

2.2.1 Evaluator issues

Foremost, in conducting ergonomic work evaluations, a professional is required to have the necessary knowledge and skills to perform this task (MacLeod, 2003). According to Wilson & Corlett (1995), understanding the complexity involved in documenting the work process, equipment, procedures, and environment, as well as evaluating specific work stressors – including posture, force, duration, and frequency – is paramount for any ergonomist. This documentation is complex given the necessary information triangulation and its dynamics, i.e., data from different sources, such as job descriptions; observations; workstation measurements; equipment specifications; and interviews with workers, co-workers and/or supervisors (MacLeod, 2003). The evaluator needs to have the necessary skills to analyze, classify and process blocks of information coming from various sources while keeping in mind the work systems functionalities and the objectives determined a priori. For this reason, understanding the ergonomic methods, their theories and the evaluation process is the most important knowledge required for developing and validating professional licensures and certification examinations (Jahns, 1999).

Furthermore, in a constantly changing work environment, organizational changes and the work process system as a whole are not easily noticed. Ergonomists working for RTW programs are required to be well acquainted with different industries and business settings as they step into different work environments on a case-by-case basis (Matheson et al., 1997). Without appropriate training on the essential components and a plan for action to conduct an ergonomic evaluation, information can be misinterpreted and misleading with possible legal and ethical implications in an already complex disability situation (Kornblau, 1998). From the literature it is unknown if when dealing with disability issues, ergonomists should have or not specialized training that can generate the knowledge and competencies in disability management. Further research on practice activities is necessary to investigate this need.

In addition to the appropriate knowledge, skills and expertise in disability management, the ergonomist's own practical experience, which is largely influenced by his/her professional background, is important in the evaluation process (Piegorsch et al., 2006). Ergonomics as an interdisciplinary science has attracted people from engineering, rehabilitation sciences, industrial hygiene, mathematics, sociology, behavioral and occupational psychology, etc. This professional background variation makes it difficult to ascertain uniformity in how practitioners are solving ergonomics problems in practice. A recent study on ergonomic decision-making showed the different frameworks employed in practice by expert ergonomists with engineering and physical therapy backgrounds (Piegorsch et al., 2006). An interesting finding from this study was the difference in the choice of using qualitative versus quantitative methods depending on the ergonomist's background (Piegorsch et al., 2006). Particularly in rehabilitation/RTW programs, many studies have shown that health care professionals themselves (with or without formal ergonomics training) are the ones carrying out ergonomic evaluations (Jacobs, 1995; Jones et al., 1999; Isernhagen, 2006a; Shaw & Feuerstein, 2004). Independent of the ergonomist's background, it is paramount that qualified individuals with proper experience, skills and knowledge on the ergonomic processes and disability issues are the ones conducting evaluations for post-injury management (Rice, 1998; Khalil et al., 1999).

2.2.2 The rehabilitation interface and the ergonomic evaluation plan

Work rehabilitation programs are facing an on-going challenge: to demonstrate to different stakeholders that their particular interdisciplinary approach indeed provides the best solution to the disability problem. Research shows, however, that there are some problems concerning communication and cooperation amongst rehabilitation actors (Latella, 2000; Jakobsson et al., 2002; Loisel et al., 2004; Loisel et al., 2005b). For example, communication skills and terminology employed by different professionals might have an impact on the team communicative process and affect the team's final rehabilitation outcomes (Jakobsson et al., 2002). The mode of information exchange might also be important to consider (Latella, 2000), as well as inter-organizational communication issues (Friesen et al., 2001; Loisel et al., 2005b).

Depending on the chosen operational approach, rehabilitation programs usually utilize different documentation and information-sharing activities, which can vary between informal meetings with stakeholders, networking, written reports, and interdisciplinary group meetings (Loisel et al., 2004). The more systematic the information-sharing approach, the lesser chances for miscommunication and consequent human error (Giacomini, 2004). When one considers the amount of data collected and information exchanged on a daily basis, the systematic information sharing by a team seems so time-consuming as to be unfeasible. To diminish the chances for miscommunication and to facilitate the interdisciplinary exchange, some authors have suggested placing a focus on the quality and precision of information and on improvement of interpersonal communication skills of the group (Margolis & Fiorelli, 1984; Eve, 2004). It is also necessary to fully understand how different disciplinary frameworks overlap and complement each other, as well as the many operational procedures where the interdisciplinary exchange occurs (Eve, 2004). These issues are particularly important for evidence-based rehabilitation programs where changes in many professional roles are occurring, which may generate role-uncertainty and a lack of confidence (Giacomini, 2004).

Within an interdisciplinary environment, the goals are first agreed upon by the team, whose members then coordinate their input for the common treatment /intervention plan (Latella, 2000). In such an environment, ergonomists need to engage in various activities that promote interaction with and among different professional disciplines (Isernhagen, 2006b). It is imperative that they communicate their findings (verbally and in writing) to the other professionals of the rehabilitation team in a consistent and coherent manner. Thus, it is important to define the ergonomic evaluation plan in relation to this interdisciplinary rehabilitation interface. Unfortunately, very little information is available in the scientific literature on the integration of ergonomic expertise into a rehabilitation team (Mital, 1995).

In examining the classical ergonomic literature, most would agree that the major steps for an ergonomic program are the following: 1) the identification of problem(s); 2) the analysis of the problem(s); 3) the development of a solution(s); 4) the implementation of a solution(s); 5) the evaluation of results; and 6) the follow-up. This basic plan of action is a dynamic process commonly adopted by

ergonomists across different fields of practice (Silverstein, 1987; Kilbom & Petersson, 1999; Luopajärvi, 1999). Specific steps, such as workplace visits, interviews with the worker, evaluation of cost-effectiveness, etc., can also be a part of this plan (Luopajärvi, 1999). These vary according to the purpose of the evaluation.

For the ergonomist working in rehabilitation/RTW programs, it is necessary that these steps are taken in coordination with the overall rehabilitation assessment process (Mital, 1995; Armstrong et al., 2001). Figure 2-2 shows a scheme illustrating the basic structure of a rehabilitation assessment interface. Similar to the ergonomic evaluation, this is an on-going and dynamic process; however, this one requires close attention to the interdisciplinary data exchange (Schut & Stam, 1994). In short, assessments related to both the worker and the workplace need to be carried out by different professionals in the team. The team then needs to make decisions regarding realistic goals for interventions concerning the individual worker and his/her working environment; re-assessments can take place when needed and are carried out by different members of the team (Loisel et al., 2004).

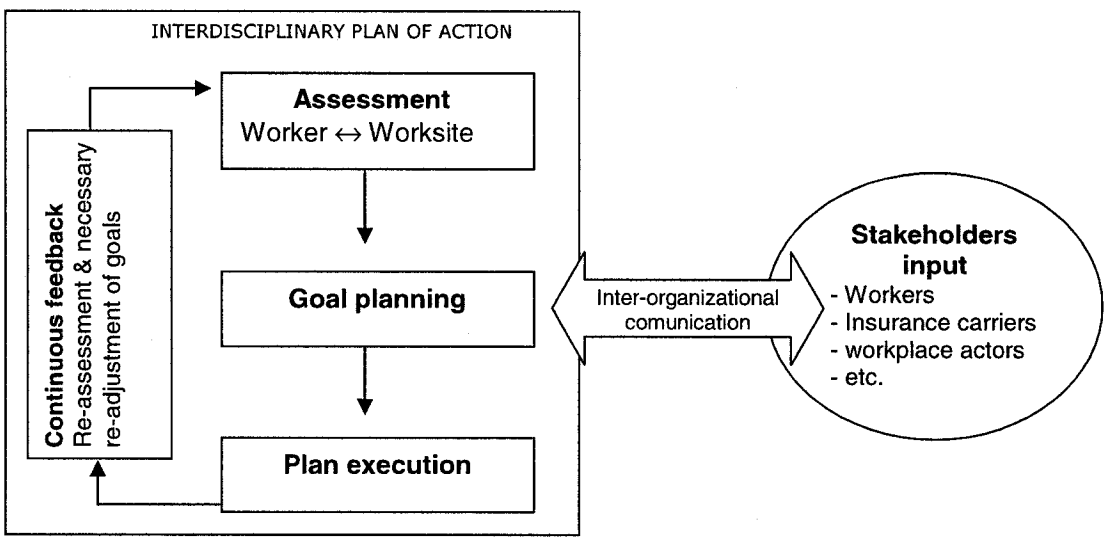

Figure 2-2: Schematic representation of a basic rehabilitation plan of action (adapted from Williams, 1987).

The workplace interventions that arise from this rehabilitation plan of action should consist not only of an interdisciplinary perspective but of the input and perspectives of all other stakeholders, i.e., the worker, his/her employer, case manager, etc. (Kumar, 2001; Pransky et al., 2004; Loisel et al., 2005b). Explaining this process further, the ergonomic evaluation is reasoned with the rehabilitation team's decisions regarding all the necessary intervention strategies for a particular client, which in turn is influenced by the perspectives of other stakeholders and their respective values and interests (Loisel et al., 2005b). Although the scheme is an overly simplified representation of the activities in most rehabilitation programs, it reinforces the need for the development of an ergonomic work evaluation plan that considers the interdisciplinary engagement in evaluating and determining solutions for the disability problem.

CHAPTER 3: OVERVIEW OF THE DISSERTATION

This dissertation investigates the practice and contributions of rehabilitation ergonomics to work rehabilitation of low back disability (LBD) cases. An array of scientific evidence proves that musculoskeletal work disability is a complex and multidimensional phenomenon resulting from the interaction of many factors related to the individual and his/her environment, and therefore needs to be managed as such. In recent years a concerted effort has been made to develop proactive disability management programs to facilitate the return-to-work (RTW) of individuals presenting this phenomenon. A few innovative work rehabilitation programs (also known as RTW programs) focusing on early, safe and sustainable RTW of those individuals at risk of prolonged disablement has been described in the literature (Yassi et al., 1995; Durand & Loisel, 2001a). These programs are tailored to each individual and function as an RTW facilitator often utilizing an interdisciplinary team model. These programs are unique in promoting strong collaboration between stakeholders, especially insurance carriers and employers. Workplace-based interventions are carried out by the team when needed. The team's ultimate goal is to provide the client with a coherent evaluation and management of the case while building the necessary partnerships between the parties involved. This type of disability care model includes a social-ecological perspective which has been promulgated in recent research in work disability prevention and integration for workers at risk for prolonged work incapacity associated with musculoskeletal pain.

As recent evidence suggests, these programs should situate the rehabilitation approach in the workplace, and they have been developed according to such a premise (Durand & Loisel, 2001). The present research is rooted in this context and attempts to respond to a particular need from this newly developed rehabilitation/RTW programs. At present there is limited knowledge regarding the incorporation of ergonomics methodology into this rehabilitation milieu, and thus more investigation is necessary. Although the application of ergonomics in disability management programs is not a new trend, various landmark reviews in the RTW

literature point to the fact that the ergonomic evaluation process utilized in rehabilitation programs is rarely described in a manner that other professionals involved in the RTW process can fully comprehend. Better understanding of the ergonomic process is an important asset for promoting more effective case management in rehabilitation and for improving inter-organization communication.

Despite the lack of studies specifically describing the ergonomic evaluation process within rehabilitation/RTW programs, in the general ergonomics literature a number of authors have presented guidance for conducting ergonomic work evaluations. Such evaluation can be described as a process to collect and analyze data related to the work situation of a person, including the job demands and work-related environmental characteristics that can influence individual and organization performance (Chengalur et al., 2004). This evaluation based on a work system perspective (i.e. human versus work interaction) may serve the purpose of job redesigning or simply data documentation of the work situation of a person that needs a rehabilitation/RTW plan. By its very principle, the information obtained from a work evaluation can involve not only physical and engineering considerations, but also perceptual, cognitive, social and organizational aspects of work (Vézina, 2001; Norman, 2003). Based on this comprehensive scope, ergonomic interventions could target the 'work' at both the level of individuals (micro ergonomics) and at the level of work organization (macro ergonomics) (Norman, 2003). This complex documentation-analysis of information requires a constant and continual systematization process and adequate professional judgment.

While work reintegration is typically individualized for each employee, ergonomists would benefit from defining the fundamental process and framework of their workplace evaluations in order to effectively document and share this information with others involved with the disability problem. This suggestion is in line with recent research advancements on the subject of inter-organization collaboration for disability management. Several studies on teamwork in rehabilitation have revealed important challenges for effective rehabilitation team collaboration and presented a few solutions for effective communication and collaboration between various stakeholders (Friesen et al., 2001; Jakobsson et al., 2002 Pransky et al., 2004).

Recent research on workplace intervention models for musculoskeletal disorders also emphasizes the need for standardized (however flexible) protocols of workplace evaluations that can allow all users of this information to obtain varied levels of information details. Another message from the same literature is the importance of obtaining a comprehensive view of the work situation (also referred as the client's work demand profile) as a means to identify the necessary workplace interventions.

On the basis of this body of knowledge, a central research hypothesis for this dissertation was proposed: ergonomists working in contemporary rehabilitation/RTW programs need to define and formalize their evaluations of the workplace in order that they can be better equipped to share, collect and communicate all the necessary information on each individual case in an effective manner without wasting resources. The primary goal of this dissertation was to obtain information on the application of ergonomics to the rehabilitation/RTW of LBD cases in terms of the workplace evaluation content, decision-making process and tools utilized. As a secondary objective, an evaluation framework was developed for the ergonomist to help optimize the work evaluation process carried out in RTW programs.

This research begins with a review of the literature focusing on two aspects of work evaluations for musculoskeletal disorders, i.e. the scope of the evaluation and its decision-making process (Chapter 2). With regards to the scope of work evaluations, the research status on the objectives and application of ergonomics in rehabilitation was reviewed. In addition, a comparison of five different models in relation to the elements covered in the work system is presented. With regards to the decision-making process involved in conducting work evaluations, the main issues reviewed in Chapter 2 were pertinent to the evaluator's decisions and the rehabilitation team's plan of action. Overall, the main objective of this review was to examine the current theoretical knowledge related to rehabilitation ergonomics for disability prevention and management that could help build a preliminary evaluation framework for practice. Several theoretical reflections emerged from this review. An important one was the fact that for effective inter-organizational collaboration to occur, the ideas and concepts behind the ergonomic evaluation should be very clear and well defined to stakeholders since they collaborate in the RTW process and are required to exchange information on many aspects of individual-environment interactions. (Rice, 1998; Larsson & Gard,

2003). This and other theoretical premises were considered in the framework development.

Once the main theoretical ideas were consolidated, this research then proceeds with an empirical investigation of the content, process and tools of work evaluations. Chapters 4, 5 and 6 present the three empirical studies included in this dissertation (Studies I, II and III respectively). Figure 3-1 shows an outline of the dissertation. For organizational purposes, this research is explained in three phases as follows:

Phase 1: definition of the content for the ergonomic work evaluation;

Phase 2: identification and analysis of applicability of existing ergonomics tools; and,

Phase 3: development of the framework.

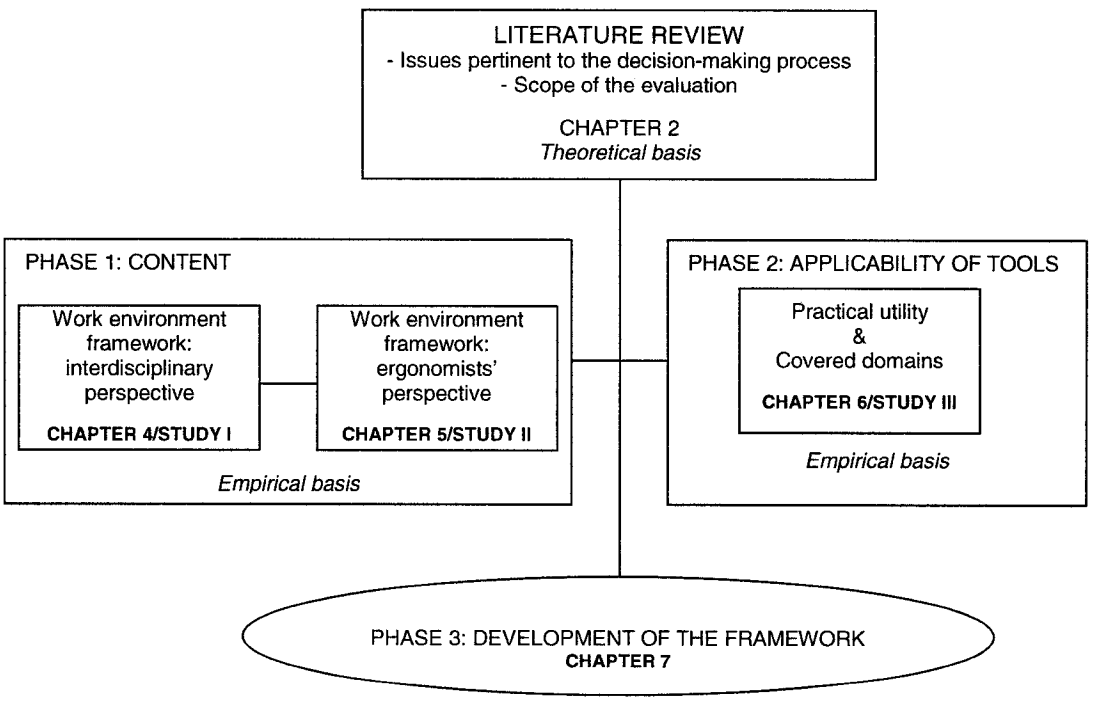

Figure 3-1: Schematic summary of the dissertation

Chapters 4 and 5 are dedicated to providing knowledge on the content of ergonomic evaluation (Phase 1). Chapter 4 (Study I) presents the interdisciplinary thematic

discourses on the work environment factors that are pertinent to the rehabilitation/RTW of ten LBD cases. The insights resulting from this exploratory-descriptive qualitative research are intended to generate an understanding of the work system from interdisciplinary group meetings that occurred in an evidence-based rehabilitation/RTW program in Quebec. At this particular rehabilitation center, the interdisciplinary team consists of a RTW coordinator, a kinesiologist, a psychologist, a general practitioner (or an orthopedic doctor), an occupational therapist and an ergonomist. Chapter 4 also presents a summary of the interdisciplinary involvement in the person-environment interface (Figure 4-3) and a discussion of the real-life aspects of RTW situations from the angle of a rehabilitation team. The main results of this study, i.e. a classification scheme of the interdisciplinary engagement on workplace issues, should help in better identifying the scope of actions of various professionals involved in workplace evaluations (such as ergonomics and occupational therapy). In fact, these findings were used in a subsequent study investigating which important aspects of the RTW of LBD cases are targeted by the rehabilitation ergonomist (Chapter 5- Study II).

On the basis of a comparison of the perspectives of ergonomists within a conceptual framework, Chapter 5 (Study II) describes the core set of work variables that are important to rehabilitation of LBD cases. The conceptual framework used is called the Work Compatibility Model (WCM) developed by Genaidy et al., 2005. A group consensus, the Nominal Group Technique, was the chosen method to collect the opinions of five ergonomists working in rehabilitation centers in Quebec. Once a consensus was reached, a deductive analysis process was carried out with regards to the main elements described in the WCM. The integrated and comprehensive perspective of the human-at-work system offered by the WCM led to discussion on a possible content for ergonomic evaluations. Several work-related factors that usually get little attention in the disability management literature were identified and discussed in relation to the elements of the WCM. The ergonomists who participated in this study revealed that in practice close attention is paid to the evaluation of physical and many work organization demands, however many personal characteristics of the employee are usually evaluated by another team member. The ultimate structure of the framework presented might invite

ergonomists working in rehabilitation/RTW programs to participate in an open dialogue about their practices with other rehabilitation professionals. This, in turn, may help to achieve more effective disability management and teamwork strategies. The results presented in Chapter 5 suggest that any ergonomic evaluation framework must consider cross-disciplinary exchange in determining workplace solutions for musculoskeletal disability.

The second phase of this dissertation was to identify suitable methods for secondary and tertiary prevention of low back pain. From an inventory of the relevant literature and consultation with ten ergonomists, Chapter 6 (Study III) reports various aspects of the applicability of the ergonomics methods in rehabilitation/RTW with special attention to the methods that have been recommended for this purpose. Applicability was evaluated with regards to two aspects: the practical utility of tools (i.e. features of various tools according to users' opinions) and to the covered domains of a set of pertinent methods. In this study attention is paid to the following issues: 1) identification of ergonomic methods recommended and/or designed for use in rehabilitation/RTW of LBD; 2) verification if these methods are used by ergonomists working in rehabilitation; 3) identification of the features considered important for tool selection according to ergonomists working in rehabilitation; and 4) evaluation of the applicability of ergonomic methods to rehabilitation according to their features and content covered. The aim was to answer these questions in a form that supports ergonomists in making effective use of existing tools. Since the nature of the problems in applying many tools in rehabilitation has hardly been explored in the literature, the results presented in Chapter 6 only provide a preliminary support in a few tools that have shown positive features. More investigations are needed in order to present more precise recommendations for application of ergonomics tools in rehabilitation. Overall, the analysis of the applicability of twenty-three existing methods to evaluate the work situation of persons with LBD might help ergonomists to improve their current evaluation strategy and the tool selection process.

Key findings of the three studies combined with the main theoretical premises identified in the literature review (Chapter 2) led to the production of an ergonomic evaluation

framework intended to meet the needs of ergonomists and respond to their difficulties in conducting workplace evaluations for the RTW of individuals with LBD. Chapter 7 describes the development of the framework in details. Both empirical and theoretical data were considered in order to elaborate a framework that could provide support for a number of decisions when determining 'what' and 'how' to evaluate the work situation of persons with LBD. From this perspective, the framework presented is not only a practical decision-support tool but also brings ergonomics closer to evidence-based practices.

It proposes to formalize the evaluation process in order to help ergonomists to more efficiently assess the realm of the workplace. It incorporates the possible application of existing tools within a plan of action for the ergonomic evaluation – the main information on preferable methods obtained from Study III was integrated in the framework. During its development phases (i.e. in phase 1 and 2) the direct opinion of the potential users of the framework (i.e. ergonomists working in contemporary rehabilitation/RTW programs) was considered. More specifically, in Study II a consensus made from a group of five ergonomists was obtained on the work factors that are pertinent to ergonomics practices; and in Study III, the perspectives of ten ergonomists working in this field was collected vis-à-vis a survey questionnaire in order to investigate the current usage of methods and also the methods selection criteria in a rehabilitation/RTW context. In both of these studies, only ergonomists with experience in the field of rehabilitation/RTW for workers presenting work incapacity due to musculoskeletal disorders were selected to participate.

In addition of taking into account the experiences of ergonomists, the framework was developed in the context of an interdisciplinary teamwork model currently in use by many RTW programs. This assured that other professionals besides ergonomists might directly benefit from the findings from this research. As such, the framework includes specifications on how the ergonomist's actions may promote inter-organization and interdisciplinary information exchange. In summary, Chapter 7 presents a framework in an algorithm format (i.e. a sequence of steps) which proposes to the ergonomist a plan of action based on empirical and theoretical knowledge of contemporary rehabilitation practices. The main rational for its

development was to create a well-planned evaluation structure of the work environment which could: 1) prevent one from taking a reductionistic perspective of the LBD problem; and 2) facilitate open dialogue among all people involved in the work disability arena vis-à-vis data exchange on the work situation of the injured worker. Such open dialogue is vital to making informed decisions about workplace interventions in practice.

Chapter 8 discusses the results presented in this dissertation in the light of the initial research objective. The overall conclusion of the dissertation and suggested directions for future research are also presented in Chapter 8. In short, the main contribution of this research is in reducing the knowledge gap between theory and practice in the application of ergonomics as part of contemporary work rehabilitation programs, with a particular focus on the workplace evaluations for LBD cases. Although the evaluation framework proposed is preliminary and further research in this field is necessary, it represents an important step forward in this regard. This new formalized approach for the ergonomist to evaluate the work system for a person with LBD might promote inter-functioning planning within an interdisciplinary teamwork model. Given the need for a more formalized procedure that incorporates cross-disciplinary exchange of information and promotes an open dialogue with all stakeholders, it is hoped that the framework presented might also contribute to promoting ergonomic best practices in field of work rehabilitation. The usefulness of the framework as a collaborative asset and as improving the ergonomist's decision-making requires additional research.

CHAPTER 4: STUDY I - INTERDISCIPLINARY TEAM DISCUSSION ON WORK ENVIRONMENT ISSUES RELATED TO LOW BACK DISABILITY: A MULTIPLE CASE STUDY

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4.1 Abstract

From both a social and cost-benefit perspective, disability prevention and associated management strategies for assisting workers with back pain are only successful if they address critical return-to-work (RTW) determining factors present in the workplace, including ergonomic factors. Despite our current knowledge of the importance of an integrated team approach targeting these factors, questions remain regarding the conceptual framework adopted by contemporary rehabilitation teams as it relates to work-oriented interventions to accommodate workers back to work. The purpose of this study was to explore and describe the work environment issues discussed by an interdisciplinary team engaged in the work rehabilitation process of LBD cases. A qualitative content analysis was conducted for 10 sample cases that underwent a rehabilitation program in Quebec (Canada). Drawing on the results of these analyses, a framework representing a synopsis of practitioners' involvement in the person-environment dynamic is presented and discussed. This study makes a unique contribution to the understanding of the 'real-life' content of an interdisciplinary activity in disability management. Thus, helping rehabilitation practitioners to build knowledge on the practical application of a cross-disciplinary framework to address work environment issues during the RTW process of those patients sick-listed due to back pain.

4.2 Introduction

Among occupational health problems affecting the workforce, low back pain continues to garner the attention of many governments in industrialized countries due to the inordinate costs it imposes on health care and compensation systems (Crook et al., 2002). Most of the costs are related to the indemnity payments and health care expenditures of a minority of individuals on long-term sickness absence (Coyte et al., 1998; Murphy & Courtney, 2000). In the province of Quebec (Canada), for instance, 70% of the total costs for occupational back pain were associated with the 7% of employees absent from work for six months (Abenhaim & Suissa, 1987).

Besides the economic burden, chronic (disabling) low back pain is considered a multidimensional phenomenon in which a confluence of social-cultural,

psychological, physical, legislative and work-related factors determine the disability duration affecting the life of the impaired individual and his/her family (Baril et al., 1994; Dasinger et al., 2000; Krause et al., 2001b). As such, it is increasingly recognized that to manage the disability phenomenon, it is necessary to adopt a more comprehensive approach to the patient and his/her surrounding environment. Research has also shown that it is essential to identify early individuals at risk for long-term disability (Waddell, 2003). For those individuals identified as at risk, it is important to focus attention on assessing individual needs and follow up with a rehabilitation plan derived according to the specific multidimensional issues present in each case (e.g. providing accommodation alternatives, ergonomics, workplace modifications, graded work exposure, cognitive-behavioral interventions, etc) (Durand & Loisel, 2001; Innes & Straker, 2002).

Different disability management models are proposed in the literature and applied in practice by work rehabilitation programs (Mayer et al., 1985; Mayer et al., 1987; Schonstein et al., 2003). For instance the work hardening program includes strategies to improve the physical and functional capabilities of the client through task simulations as well as interventions geared towards psychosocial problems (Schonstein et al., 2003). Another approach is the client-centered ecological approach with the goal to include the design of a particular job and a particular work environment in the rehabilitation process of the injured worker, thus creating a supportive, dynamic environment which enables him/her to work at the safest and most effective levels (Matheson et al., 1997). Despite these clinical and ecological approaches, there are other models that include a social perspective (Baril et al., 2003). This variation in the model adopted across rehabilitation practices has been a subject of prolonged debate, especially over the past five years with publications of relevant reviews in the field of RTW interventions (Staal et al., 2002; Ozguler et al., 2004; Pransky et al., 2004). Independent of our knowledge of which model should be applied in practice, there is extensive empirical evidence demonstrating that linking the rehabilitation plan and goals to the workplace situation seems to produce more positive RTW outcomes (Franche et al., 2005). Moreover, it is well recognized in the recent literature that this link should insure that appropriate interventions to improve work conditions and workplace psychosocial factors are part of the RTW plan (Durand et al., 2003; Ozguler et al., 2004).

Since more and more contemporary work rehabilitation programs are adopting a workplace-centered approach rather than the traditional clinical one, (Durand & Loisel, 2001; Loisel & Durand, 2003; Ozguler et al., 2004), rehabilitation practitioners are facing the dilemma of changes in practice. They are required to adopt new RTW planning models to intervene and evaluate the worker in his/her work environment, coherent with changes that are occurring in the work itself (due to a change in global economy) (Polanyi & Tompa, 2004) and consistent with emerging scientific evidence on disability management (Staal et al., 2003; Pransky et al., 2004; Franche et al., 2005). Westmorland et al. (2002) have pointed out that an effective client-oriented RTW plan is highly dependent on practitioners' knowledge of a full range of on going work factors that might impede or facilitate an individual's successful RTW. These are in fact dynamic constructs that can provide practitioners with a great opportunity for involvement (Westmorland et al., 2002). However, the literature on how practitioners are dealing with these key work factors and developing workplace-based interventions is still scarce, and in particular there is a lack of studies investigating the real-life aspects of the work environment that practitioners collaboratively consider for appropriate RTW planning (Franche et al., 2005; Young et al., 2005).

Moreover, rehabilitation for those at risk of prolonged back disability (in the subacute or chronic phases) requires an interdisciplinary team approach with different practitioners working in close collaboration (Loisel & Durand, 2003; Loisel et al., 2004). The team – which usually includes psychologists, occupational therapists, physiotherapists, physicians and ergonomists – is required to integrate a broad array of information into a plan of action or a course of treatment that can help balance work demands with employee's capabilities. To accomplish this, the team needs to perform collaborative and collective tasks such as communication, evaluation, decision-making, problem solving, brainstorming, and networking with other stakeholders (Margolis & Fiorelli, 1984). In practice, interdisciplinary group meetings constitute one of the most essential communication strategies employed by work rehabilitation programs in terms of providing quality of care and promoting occupational re-integration. Information gained directly from these meetings could provide an integral and practical approach to better understanding work environment dimensions from a teamwork standpoint, since this form of dialogue

represents a real-life phenomenon of information sharing between team members with different professional backgrounds (Jakobsson, 2002; Giacomini, 2004). The present study investigates the content of rehabilitation team dialogues that occur during interdisciplinary group meetings, with direct attention paid to aspects of interventions linked to the work environment across disciplines as an alternative to better understand the overall RTW plan model from a pragmatic viewpoint.

The literature on teamwork for contemporary work rehabilitation programs is very limited in number and also in scope since most studies reflect one specific disciplinary framework or another. In particular, the ergonomics and occupational rehabilitation literature on managing LBD seems to be somewhat disjointed. For instance, evidence shows that the practice of ergonomics might provide compelling information on workplace conditions and an employee's capabilities vis-à-vis the process of assessing, designing and modifying work systems with the purpose of facilitating the work accommodation process (Water & MacDonald, 2001; Anema et al., 2003; Norman, 2003). In this case, the ergonomics framework might involve not only physical considerations, but also perceptual, cognitive, social and organizational aspects of work (Vézina, 2001; Norman, 2003). In the ergonomics literature, emphasis is usually given to maximizing the efficiency of the worker through improving the overall system's requirements. On the other hand, in the occupational rehabilitation literature much emphasis is given to restoring the basic function of the client as a necessary part of the return to work role (Canelón, 1995). According to this approach, when psychosocial and organizational factors are significant contributors of disability, work environments are difficult to simulate (Polanyi & Tompa, 2004). Rarely found are studies representing a cross-disciplinary bridge between the two models and methodologies. Frings-Dresen & Sluiter (Frings-Dresen & Sluiter, 2003) has proposed such an approach by developing a job-specific protocol that incorporates both the rehabilitation medicine and the ergonomics perspectives. The authors suggested that the new tool could serve as a starting point during meetings between employers and workers in developing RTW plans.

Studies demonstrating which specific ergonomics framework should be incorporated into the rehabilitation context might contribute to the advancement in our knowledge of workplace-based interventions (Armstrong et al., 2001; Durand &

Vézina, 2005). As previously mentioned, the lack of a comprehensive and holistic view of all the elements of the work environment – commensurate with a teamwork practice that includes both occupational rehabilitation and ergonomics – makes it difficult to determine which aspects of each disciplinary framework are being addressed in real-life by contemporary rehabilitation programs. This study started from the hypothesis that understanding the overall content of discourses between team members on work environment issues could be the vital first step towards more specific recommendations and advice for application of ergonomics methods and frameworks in this type of rehabilitation milieu.

4.3 Purpose

The aim of this study was to explore and describe the work environment issues as discussed by an interdisciplinary team engaged in the job reintegration of low back disability (LBD) cases. For the purpose of this article, LBD is defined as a condition where the employee has been continuously unable to work because of back pain for at least 4 weeks (subacute or chronic stages) (Frank et al., 1998). The definition of work environment used here is: "the physical, chemical, biological, organizational, social and cultural factors surrounding a person within his/her workplace" (ISO 6385, 2001).

4.4 Study's context

An evidence-based work rehabilitation program named PREVICAP (PREVention of work handICAP) was the study setting. This program, implemented in the south shore of Montreal (Quebec, Canada), was developed based on the Sherbrooke model, which links clinical and occupational interventions for the purpose of early identification and treatment of workers at risk for prolonged disability (Loisel et al., 1994; Loisel et al., 2003). PREVICAP is an innovative and evidence-based RTW program that promotes a progressive reintegration of the worker to his/her regular job vis-à-vis an interdisciplinary team working in close collaboration with the case manager, the attending physician and the employer. PREVICAP's impact theory, content, and mode of operation are presented elsewhere (Loisel & Durand, 2003; Durand et al., 2003).

At this particular rehabilitation center, the interdisciplinary team consists of a clinical coordinator, a kinesiologist, a psychologist, a general practitioner (or an orthopedic doctor), an occupational therapist and an ergonomist. All the team members have at least 2 years of experience in the work disability prevention field. They meet weekly to discuss each case in terms of progression and course of action during the two main phases of the program: the preparatory-Therapeutic Return to Work phase (pre-TRW phase); and the Therapeutic Return to Work phase (TRW phase) – i.e. a supervised and progressive return of a worker to his/her original job in parallel with clinical rehabilitation. At the time of this study, the clientele admitted to this program are workers with musculoskeletal injuries (mostly with back or upper extremity injuries) who are away from work between 2 and 12 months but who maintain their employment status and are compensated by the workers' compensation insurance board of Quebec (Durand & Loisel, 2001).

4.5 Method

4.5.1 Design

According to the definition by Yin (Yin, 1994), a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. The analysis of multiple cases strengthens the accuracy of results by replicating pattern-matching, thus increasing confidence in the robustness of the theory (Yin, 1994). This rational is commensurate with the objective of this research and therefore, a multiple case study design was used to better comprehend the work environment information discussed by an interdisciplinary rehabilitation team.

4.5.2 Data gathering

This study consisted of a secondary analysis of a pre-existing database from a larger study entitled: Decision-making to facilitate a return to work - Exploratory study of the aspects of decision-making in an interdisciplinary work rehabilitation team (Loisel et al., 2004). The database contained the records of weekly interdisciplinary team meetings for 22 patients who underwent the PREVICAP program between the years 2000 to 2001 (a total of 75 hours was recorded). The meetings were videotaped and transcribed verbatim in a PC word processor format.

The principal investigator submitted and received approval from the PREVICAP program to gather and analyze this data, adhering to the recommendations of Canadian intellectual property law (Canadian Intellectual Property Office, 2004). Confidentiality and an anonymous presentation of findings were guaranteed. The personal identification of all patients and team members was omitted from verbatim records before data analysis began.

4.5.3 Study sample

From the 22 cases pooled from the original database, 15 cases corresponded to problems in the lower back region and these were the ones considered for content analysis. Based on literature guidance, two case selection criteria were decided a priori: 1) both similar and dissimilar cases should be included in the analysis to ensure diversity in the case sampling (Stake, 1994); and 2) the analysis of cases would continue until confronted with a case which did not provide additional knowledge of the phenomenon studied, i.e. when the point of "theoretical saturation" was reached (Mucchielli, 2002).

Initially, five cases were selected for analysis based on heterogeneity of the client's profile (age, gender and job title), the medical diagnosis, and the employment situation (i.e. if he/she would be prepared to return to the same job as previous injury/absenteeism or to a new job). Subsequently, the analysis of the remaining cases continued until the point of saturation was reached (Mucchielli, 2002) Considering that this study had a content analysis focus, this implies that analysis continued until a case did not provide any additional categories related to work environment.

Accordingly, a total of 10 cases are representative of the findings of this study and their main characteristics are shown in Figure 4-1. This sample included cases that differ in terms of employment situation. Seven cases involved work rehabilitation plan targeted at preparing the worker to return to the same job and employer as he/she had before injury/absenteeism (group 'original job'). In the other three cases, the team worked towards preparing the worker for a 'different job' and employer than he/she had originally. Although the first group represents the most typical clientele in this program, both groups were included in the sample since the objective of analysis was to integrate both particularities and commonalities

between cases to maximize what could be learned from the phenomenon of interest (Stake, 1994).

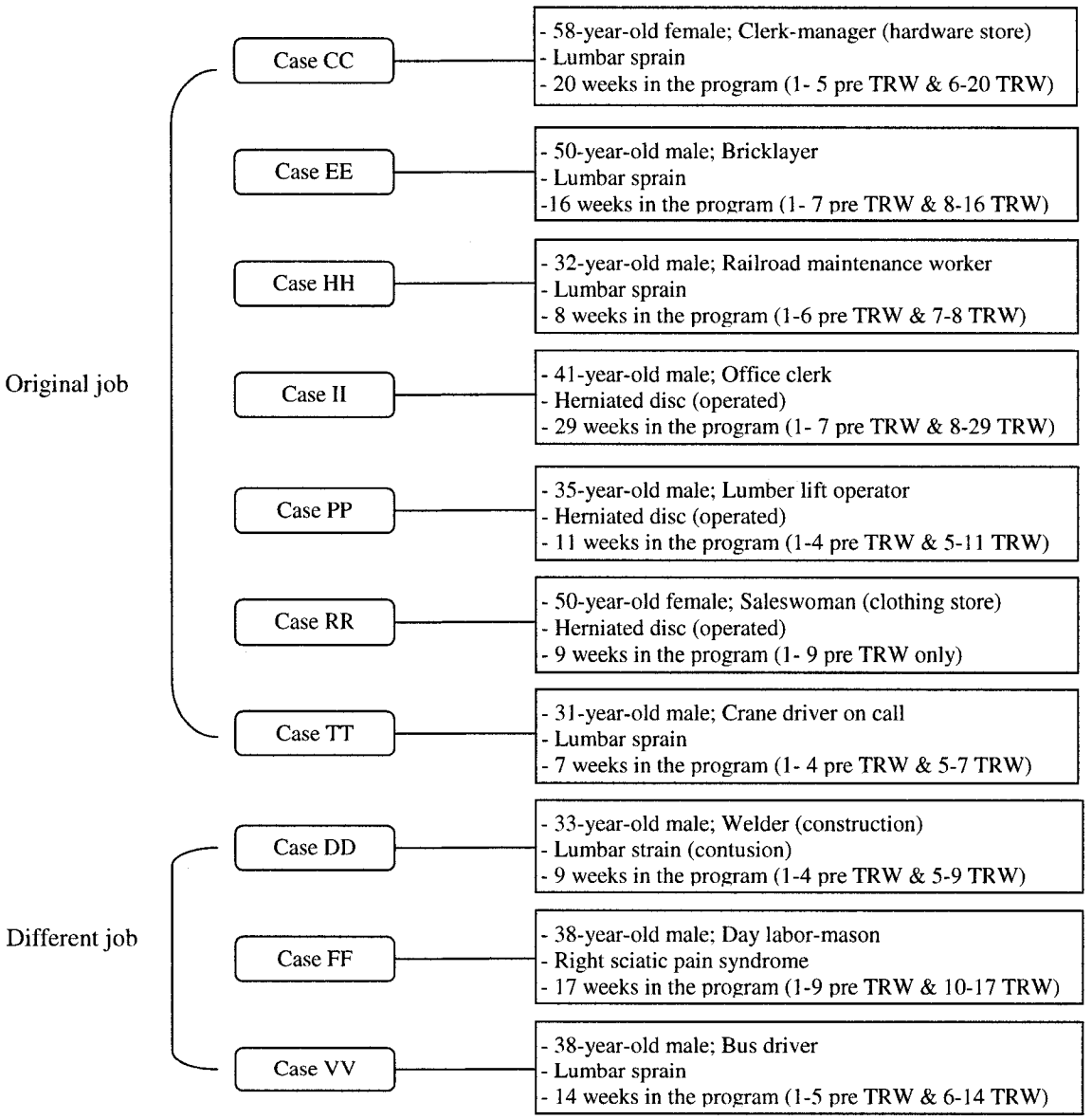

Figure 4-1: Main characteristics of the cases (employment situation, age, gender, original job title, medical diagnosis and program duration).

4.5.4 Data analysis

A qualitative content analysis was applied to examine the content of the team dialogues for each case. This technique is commonly used as a mode of textual analysis which involves sorting the content into categories directly corresponding to the data without references to which cases they came from (Weber, 1990).

Thus, data gleaned from the verbatim was coded, compared and classified to reflect emerging categories related to the phenomenon studied, i.e. work environment issues discussed by an interdisciplinary team. The process of identifying meaningful segments in the data was a dynamic process that included various activities conducted by the principal investigator, including: systematic reading (i.e. each case was read individually in chronological order); assignment of a category name to each relevant segment of data; use of an open code system to facilitate continuous revision of extracted categories; repeated review of the data; identification of the team's keywords; creation of a list of categories for each case analyzed; and other tasks (Miles & Huberman, 1994).

The coding system was used to help reorganize (or eliminate) those categories that appear to have the same characteristics or were identical (Miles & Huberman, 1994). This required that the investigator, prior the data analysis, observe and learn the language rules of the team (Weber, 1990). Attendance to the rehabilitation meetings took place two months before analysis began (the investigator participated as an observer). Furthermore, two co-investigators independently reviewed the code system created by the principal investigator using one case as example. They were asked to verify the general consistency (intra-coder reliability) and appropriateness of the system used (Miles & Huberman, 1994). Based on their recommendations, specific coded categories were re-evaluated, but overall the consistency and appropriateness of the code system used were considered very satisfactory. As an example, the category entitled 'postural load' was changed to 'postural demands', since the discourses were referring to the postural requirements of the job rather than the risk factor "postural load".

With regards to the theoretical triangulation, it was anticipated that the extracted data should be compared with existing theoretical knowledge and frameworks (Denzin, 1988). A brief literature review on conceptual models related to person-work environment dynamics and the terminology commonly used for describing work-related factors and disability predictors, helped to ensure that others working in the field could easily identify the information provided herein. Moreover, we carefully considered that none of the information gathered from the literature was artificially forced into data and that the results were presented in a natural manner (Miles & Huberman, 1994).

4.5.5 Trustworthiness strategies for quality assurance

To assure scientific rigor and coherence of the results' interpretation and presentation (Taylor & Bogdan, 1998), this study followed two subsequent steps as shown in Figure 4-2.

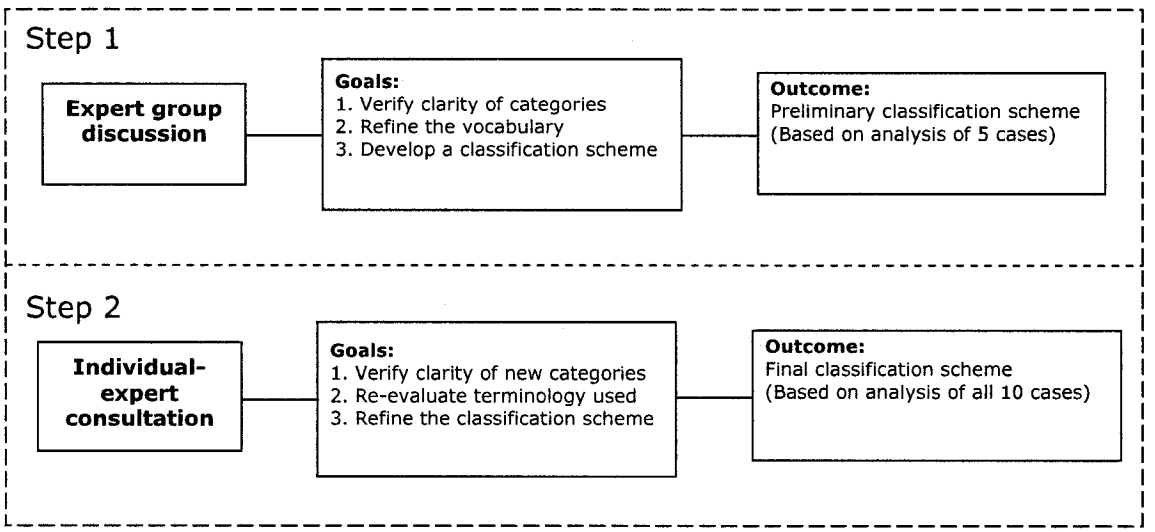

Figure 4-2: Steps of the trustworthiness strategy (quality assurance).

Step 1

In the initial phase of the data analysis process, a list containing all work environment categories from the first 5 cases analyzed was generated. This preliminary list formed the foundation for the first data verification activity: an expert group discussion. The group consisted of one industrial engineer with ergonomics expertise; one ergonomics researcher; one physiotherapist with ergonomics training (Masters Degree); one work rehabilitation researcher (animator); one anthropologist researcher with expertise in work rehabilitation; and the principal investigator (observer). The specific goals of this group activity were: 1) to verify the clarity of all categories that emerged from the data; 2) to discuss terminology issues related to these categories, i.e. to refine the vocabulary; and 3) to develop a classification scheme so that the work environment information can be displayed coherently, thus facilitating a better understanding of the findings. Regarding the latter, the categories extracted from data were grouped in meta-categories during this group activity, and the final outcome was a classification scheme containing categories and meta-categories without specification of their hierarchical levels.

The group's meeting lasted 2 hours. A technique called TRIAGE (Technique for Research of Information by Animation of a Group of Experts) and an organization strategy called affinity diagramming guided the group's decisions and helped classify the information, respectively. The TRIAGE is a structured and inductive method for collecting information that enables group consensus (Gervais & Carriere, 2000). The affinity diagramming is a practical activity commonly used in participatory ergonomics and in industrial quality improvement workgroups to sort large amount of data into logical groups. It requires the placing of a number of categories and/or elements descriptors on the wall, after which the group makes decisions on how the categories/elements should be grouped together. Photographs and notes were taken to register the outcome of this meeting. The relevant comments and questions that arose during this session served as guidance for data revision and, when it was judged necessary, subsequent modification on the

terminology was applied. A preliminary classification scheme was elaborated by the group and reviewed later in the following step of data analysis.

Step 2

The saturation point was reached with the additional analysis of 5 cases, after which it was necessary to review the classification scheme since new categories emerged from data and they needed to be included in the scheme. Therefore a second verification activity was carried out. It consisted of an individual expert-opinion consultation (the engineer with ergonomics expertise who was present in the first activity). The goals of this activity were: 1) to verify the clarity of the new categories added to the scheme; 2) to re-evaluate the terminology used; and 3) to refine the final classification scheme. This activity was audio taped and modifications to the scheme were made according to agreements between the principal investigator and the expert consulted.

4.6 Results

4.6.1 Results' presentation

Considering that the study's objective was to describe in words the topics of conversation during the interdisciplinary meetings, careful attention was given to how the results should be presented. As Taylor and Bogdan (Taylor & Bogdan, 1998) suggest, a true account of the phenomenon is best achieved by using the informant's own words. Most of the categories extracted from the data (Table 4-1) originated from the team members' own words and expressions; in this particular case we are referring to the French-English translation with validation by an official translator. As an example, the category 'access to the workplace' (group D) represents the exact words used by the team members when they were discussing the initiation of contact with workplace parties.

Table 4-1: Classification scheme of work environment issues discussed by an interdisciplinary team.

A. PHYSICAL WORK & ENVIRONMENT CONTEXT		
PHYSICAL DEMANDS Manual handling demands: - Type - Level - Exposure-time - Lifting characteristics Postural demands: - Type * - Exposure-time Repetitive motion demands: - Type - Exposure-time	**PHYSICAL ENVIRONMENT** Safety issues Workplace layout Exposure to vibration: - Type - Level - Exposure-time Vehicle characteristics Chemical hazards Floor condition Seating characteristics Thermal conditions Tools in use: - Type - Design characteristics - Exposure-time	
B. ORGANIZATIONAL CONTEXT		
CHARACTERISTICS OF THE ENTERPRISE: Size Business type * Clientele Injury incidence rate Corporate culture Financial issues Work season Existence of labour shortage Production demands	**SOCIO-ORGANIZATIONAL STRUCTURE** Relationship with employer * Relationship with supervisor Relationship with co-worker Union involvement in the RTW process Workplace receptivity * Employer flexibility regarding the TRW plan Employer time-pressure regarding RTW Employer acceptance of proposed ergonomic solution Level of engagement of the work team Co-worker (s) support regarding TRW Commitment to health and safety Previous experience with ergonomics Recognition and respect at work	
C. INDIVIDUAL & JOB CONTEXT		
INDIVIDUAL FACTORS Personal work style Job satisfaction * Goals & preferences regarding TRW Work experience in field * Previous job experience * Length of last employment * Nature of work accident Qualifications/Aptitudes Self-motivation towards work * Self-efficacy towards work Self-regulation regarding work break periods Career prospects Readiness to RTW *	**JOB PERFORMANCE FACTORS** Task(s) performed * Working posture description Level of task complexity Level of mental workload Level of task difficulty * Level of physical fatigue Work related stress Work technique Perceived effort Pace of task performance	**JOB RELATED FACTORS** Job title * Job content * Skill demands: - Type * - Level Job security * Job contract Job certification Work schedule Work shift Teamwork structure Pace required in the job

Table 4-1: Classification scheme of work environment issues discussed by an interdisciplinary team (continue and end).

Financial factors that affects worker's welfare Involvement with legal action Level of engagement in the trade union Level of job autonomy Attitude towards preventive measures Anthropometric issues Physical capacity		
D. INTERVENTION CONTEXT		
INTERVENTION PLAN Work exposure time during TRW * Timing for job analysis Timing of initiation of TRW * Necessity to begin the work internship Structure of the TRW * Deliver the same message regarding TRW plan Need of job analysis Need of specific ergonomic analysis Ergonomic intervention/ recommendation Number of hours needed for ergonomic intervention Occupational Therapy intervention Reassurance regarding self-efficacy towards work	**IMPLEMENTATION ISSUES** Access to the workplace * Variation of job content Feasibility of work activities * Feasibility of job analysis Case manager involvement on TRW plan Negotiation with workplace parties * Communication with workplace parties Availability of assistance Changes in the organization Change of employer Availability of work internship	**WORKER'S PROGRESS** Pre-TRW progress * TRW progress * Tolerance to work exposure time * Compliance with OT recommendations Follow-up of the ergonomics intervention
		* *Categories common to all ten cases*

When a team member's keywords did not provide a clear description of the topic of discussion, categories were elaborated by the principal investigator and verified during the expert group and the individual consultation activities described earlier. The choice of wording was based on clarity of meaning -- i.e. self-explanatory in nature-- and when appropriate on the terminology encountered in scientific literature. For example, the category 'feasibility of work activities' (group D) was elaborated upon to give the reader an explicit view of the team's discussions on the aspects related to activities that are possible for the worker to do in the TRW context. On the other hand, the category 'manual handling demands' (group A) is a common term encountered in the ergonomics literature, which refers to the physical demands related to handling any kind of object or load.

Moreover, we carefully avoided the use of positive or negative connotations; more specifically, no adjectives were added to them. The category 'level of task difficulty' (group C) illustrates this. In case TT for instance, a team member had mentioned: "it is very difficult for him to slide the wood mesh below the truck crane..." In case EE the same category was identified but had the opposite connotation "it is quite easy for him to do the brick work with the small bricks."

Another issue concerning the display of findings is that the classification scheme aimed to provide as much detailed information as was encountered in the data. For example, for the category 'postural demands' (group A) it was found that the team could be referring to the 'type' (i.e. twisting the trunk, static postures, or any asymmetrical posture description) and/or the 'exposure-time' (i.e. how long or how often the worker stays in that particular posture). They could be as specific as: "...his body posture is most of the time asymmetric with one leg in front of the other and his back twisted to one side" (case EE). Or they could just mention that: "...his work allows frequent postural changes, but they are nevertheless constrained postures" (Case FF).

4.6.2 The study's sample

During the analysis of the cases, one particularity was observed in the 'different job' group (Figure 4-1). In the meetings the team discussed various workplaces where the worker could be placed during the realization of the TRW program. However, the only specific category that emerged exclusively from this group sample was 'availability of work internship' (Table 4-1: group D).

It represents the team discussion of the resources they have available – or their lack thereof – to assign a worker to a new job where he/she can have a certain level of work exposure while in rehabilitation. An example of such a resource is the team benefiting from a good contact with an employer who is interested in collaborating by accepting the injured worker in the workplace while he/she completes the rehabilitation program (case FF).

The amount of information obtained from each case varied according to: 1) the total time the worker was enrolled in the program, which fluctuated from 7 to 29

weeks; and 2) the length of each phase of the program (i.e. pre-TRW and TRW phases). As expected, the longer the TRW phase, the more information obtained on work environment issues – possibly due to the fact that during that phase the team had on-going access to information collected directly from the workplace, particularly that obtained by the worksite visitors (occupational therapist and an ergonomist).

4.6.3 The work environment information

Table 4-1 shows the classification scheme obtained according to the group activity and individual consultation (Figure 4-2). Four major groups of data were identified and classified as follows: physical work and environment context (A); organizational context (B); individual and job context (C); and intervention context (D). The topics of discussions (i.e. the categories) on each group concerned the client's work situation prior to and/or during enrolment in the program.

In Table 4-1, the symbol '*' denotes the categories common to all ten cases. The idea was to provide the reader with a better appreciation for the commonalities between cases, emphasizing the main topic areas in the interdisciplinary group meetings. A simple comparison between cases, using each case's list of categories, was the method adopted to obtain this data (Miles & Huberman, 1994; Stake, 1994). With respect to particularity, only the category 'chemical hazards' (group A) was found exclusively in one case. This category refers specifically to the worker's exposure to titanium powder (case HH). The remaining categories are representative of at least two cases. This was not anticipated during the case selection process and does not constitute redundancy of findings; rather, it was an important asset during the analysis because it served as a thematic confirmation between cases (Miles & Huberman, 1994).

The majority of the categories listed are self-explanatory in nature (e.g. 'job title', 'workplace layout', 'exposure to vibration', 'readiness to RTW', etc). For those categories in which the investigators believe that additional clarification for the reader is required, short descriptions along with exemplification using member's quotes are presented in the following sub-sections.

Physical work & environment context (group A)

It is important to highlight that the categories in this group are related to the team's discussion on work requirements, as compared to how the individual worker is carrying out the task. The categories related to a worker's performance on the job are included within the group C (Individual & Job Context).

The 'physical demands' meta-category represents work requirements that are known as ergonomic factors. As shown in Table 4-1, the team discussions on 'manual handling demands' could be related to 'type' (i.e. lifting, transporting, pushing or pulling activities), 'level' (i.e. heavy, very heavy, hard or easy), 'exposure-time' (i.e. frequency and/or duration of the handling activity) and/or 'lifting characteristics' issues (i.e. weight, bulkiness or size of the object and reach distances). One team member could be as specific as "he needs to lift a 40 lbs brick and place at his chin height"; while in another dialogue segment he/she just mentioned "he does very heavy lifting" (case EE). Another example that explains this category and demonstrates the level of specificity discussed, is the following comment: "he transports lots of materials often considered heavy. It could vary from 30-40 lbs on a frequent basis and 125 lbs occasionally" (case FF). This statement indicates the 'type', 'level', 'exposure-time' and 'lifting characteristics' related to 'manual handling demands'. The worksite evaluator (both the occupational therapist and the ergonomist perform this function at PREVICAP program) is responsible for providing this information to the team. They usually use various means to gather information on job descriptions, including interviewing with the employer, the supervisor and the worker (over the phone or in person), requesting a job report from the insurance party, or even by conducting a walk-through.

In the meta-category group 'physical environment', 'safety issues' could refer to discussions on the safety measures of the company or the worker's use of safety equipment. 'Seating characteristics' are related to the ergonomic aspects of the seat design, including its measurements and conditions. For example, on case PP a team member talked about the conditions of the lift truck seat as follows: "...the seat is an old seat...it is all damaged, the entire foam on one side doesn't exist anymore, he

has to sit towards one side, otherwise he feels the metal. Definitely it is not an appropriate seat."

Organizational context (group B)

Within the meta-category 'characteristics of the enterprise', 'work season' refers to the period when the business reaches its peak or when it is very slow. For instance, in case CC the team discussed the fact that the employee had to increase her number of working hours because the business intensifies during the summer period (hardware store).

Within the other meta-category 'socio-organizational structure', the category 'workplace receptivity' is a very common expression used by team members when they are discussing the workplace's general atmosphere and structure (welcoming or not) after their first contact with the employer and initial worksite visit. This represents a particular discussion topic for work rehabilitation programs that include a modified work environment component.

It is important to mention that in this meta-category most topic areas were intrinsically related to the team's discussions of 'intervention context'. For example, the worker's 'relationship with supervisor' and level of 'co-worker (s) support regarding the TRW' were discussed in the context of decision-making vis-à-vis the 'structure of the TRW'. For example: in case HH, the team mentioned the social support received at work when they needed to make a decision as to which group of employees this particular worker should be placed with.

Individual & job context (group C)

All personal factors that were listed in this group were only part of the data analysis if the team's dialogues were referring to the workplace. In other words, personal factors outside the work environment domain (such as related to insurance carriers, clinical progress, family or socio-cultural issues) were not included in the analysis.

Thus, the 'individual & job context' group includes discussion topics on work-related personal factors, worker's job performance factors, and his/her current or previous job characteristics. Although some categories included in the meta-category 'job-

related factors' might be related to 'socio-organizational structure' or 'physical demands', they were classified within the group C because they exclusively represent the descriptive information related to a particular job of an individual (not necessarily work requirements). For instance, 'teamwork structure' refers to the descriptive information on the number of people a worker needs to collaborate with. The dynamics and hierarchical positions within the worker's team are not part of this category, nor were interpersonal work demands (listed on group B as 'socio-organizational structure').

In the meta-category 'individual factors', the 'work experience in field' refers to the employee's number of years in the field or his/her overall level of experience (e.g. "he is very experienced as a crane operator..." – case TT), while 'previous job experience' represents discussions on any information related to the client's experience specifically during his/her pre-absenteeism employment. The following verbatim statement illustrates this point: "...he already had some experience within this company...the supervisor has known him for 15 years and knows he's a competent worker" (case PP).

Within the same subgroup, 'self-motivation towards work' refers to the worker's own motivational aspects to engage in his/her job (e.g. the value of the work for him/her and being proud of his/her job function). 'Self-efficacy towards work' concerns the confidence the worker has in his/her ability to perform the job, e.g.: "there was a concern on his part related to the possibility of another serious and disabling injury, but at the same time he is a worker who promotes himself favorably when it comes to his performance as crane operator, who even saw a possibility of working on the smaller cranes if the larger cranes were problematic" (case TT). Additionally, the 'physical capacity' category relates to dialogue statements on employee's physical tolerance observed during his/her actual work exposure, rather than specific functional limitation measurements taken during task simulations at the clinic.

In the meta-category 'job performance factors', one can note that some categories are related to cognitive demands posed over the individual worker (e.g. level of task complexity and level of mental workload), others are related to physical demands

while the worker carries out a task or tasks (e.g. level of physical fatigue and working posture), and others are related to both cognitive and physical demands (e.g. perceived effort, level of task difficulty). No specifications were included in the final classification so as to allow the reader to appreciate all factors related to job performance as a whole and avoid extrapolation of data interpretation, since these concepts of cognitive demands and physical demands might be interpreted beyond what was discussed by the team.

The category 'work technique' relates to the worker's body movement/gesture adopted during the performance of certain activities, such as building a brick wall (case EE) or welding a broken rail track (case HH). 'Perceived effort' is a commonly used terminology in the ergonomics field and it describes the team discussions on the worker's perception of the level of physical work demands.

For the last meta-category of this group – i.e. 'job related factors' – 'job security' refers to how unstable or stable is the current employment situation; 'job certification' represents the discussions on required license or work permit or other competence level formally recognized by an official body for doing a modified duty; while 'job contract' refers to the discussions on renewal of an old contract or on getting a new one. The latter category corresponds to dialogues related to cases in the construction industry (cases EE, PP, TT, DD and FF).

Intervention context (group D)

Within the meta-category containing information on 'intervention plan', the topic area 'timing of initiation of TRW' refers to when it is the appropriate time to send the worker back to the workplace during the transition of pre-TRW phase to the TRW phase. 'Structure of the TRW' includes issues related to the TRW goals and plan such as: length of the TRW program, type of modified activity, work schedule, and others. It was also observed that the category 'ergonomic intervention/recommendation' was discussed in two different contexts: one related to ergonomics recommendations on preventive measures such as the use of safety equipment (case PP) or the inclusion of break periods (case HH); the other refers to

ergonomics redesign issues, e.g. getting new equipment (case DD) or modifying a workstation (case PP).

For the second meta-category – i.e. 'implementation issues' – 'feasibility of work activities' refers to discussions about which tasks are possible and available for the worker to do during both the pre-TRW and TRW phases. In 'feasibility of job analysis', the team discussed the possibility of performing a job analysis and the difficulties they encountered in performing such a task, such as in the case of a crane operator on call (case TT). In this particular situation, the worker could not tell the worksite evaluators in advance when and where he would be working on a given day, thus making it difficult to arrange a worksite visit. 'Changes in the organization', such as in management style or target market, were also variables found in the verbatim dialogue related to the implementation of the rehabilitation plan (i.e. workplace intervention).

4.6.4 Summary of the work environment information

Figure 4-3 shows a schematic summary of the work environment information as discussed by PREVICAP's rehabilitation team. This framework demonstrates that the discussions on issues related to 'intervention context' for employees on sick-leave due to back pain are based on the person-environment interface and its inherent complexity.

Within this interface, we identified dimensions pertinent to the workplace per se from both macro and micro levels (i.e. the trapezium diagram), which included issues related to the work organization, the physical environment and physical demands. These dimensions define the nature of a particular job to be dealt with by the worker; in other words, each case contains information on a particular job's duties (i.e. job related factors represented as an upside down triangle) that can be characterized by the dimensions that exists in the organization from a macro to a micro level.

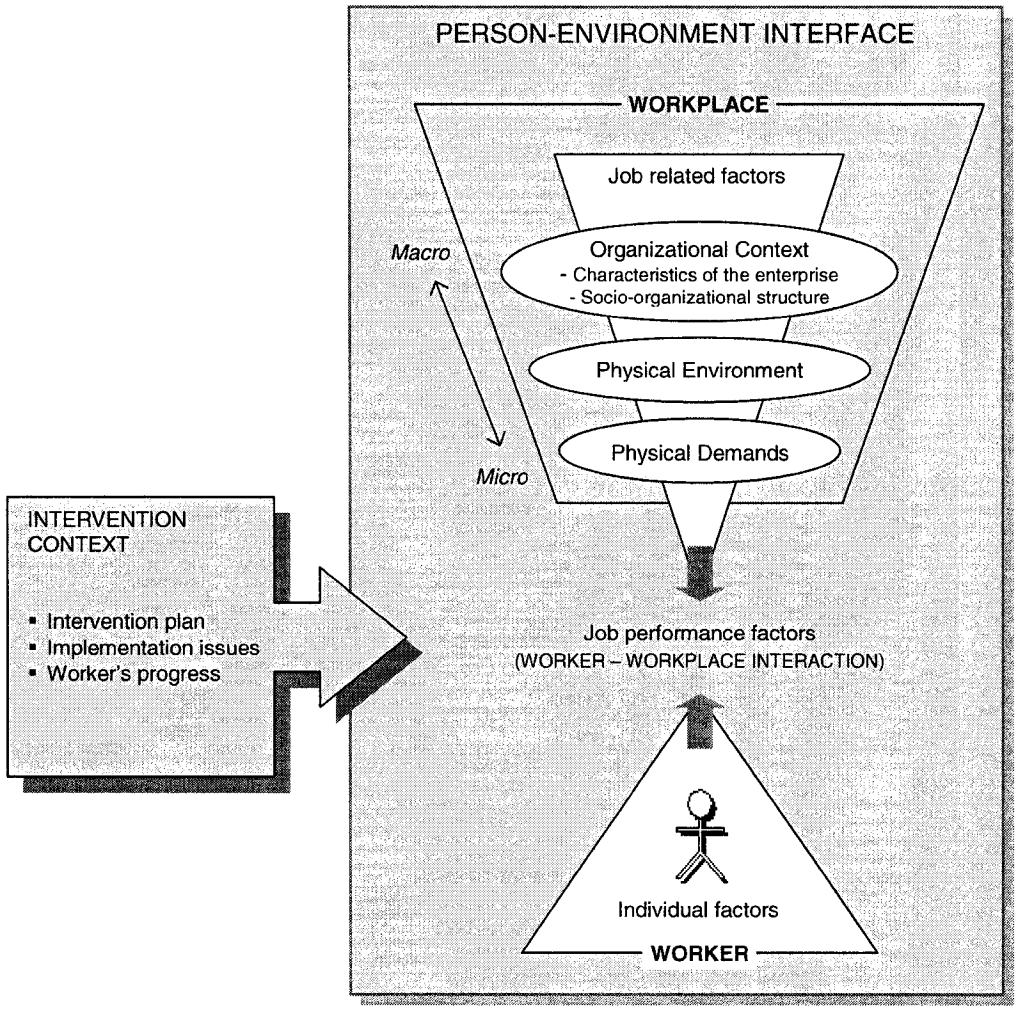

Figure 4-3: Summary of work environment information from an interdisciplinary perspective.

Since the focus of the study was on issues exclusively related to the work environment (personal factors outside the work domain are not considered), the worker is also illustrated within the 'person-environment interface'. The 'job performance factors' group is situated in between the workplace (i.e. trapezium diagram) and the worker (i.e. the triangle diagram). The converging arrows, pointing towards the individual's job performance factors, indicate the interaction point of the relationship between the injured worker and his/her workplace (micro level).

Despite the fact that Figure 4-3 might present the illusion of a comforting static view of the person-environment-intervention context, it is actually highly dynamic in the sense that it continually evolves with time. The interventions are constantly modified throughout the RTW process to reflect the periodic assessments made to a constantly evolving interaction between the worker and his/her work environment. Indeed, observations and assessments done by the team throughout the work reintegration process and identified in the verbatim dialogues in turn provoke new weekly discussions on improvements of intervention effectiveness. Any modification on the intervention strategy reached by consensus among team members will impact the accommodation of the injured employee. This is a closed loop (or feedback loop) system, i.e., one which regulates itself to reach sustainable RTW goals based on the team's shared knowledge and actions.

4.7 Discussion

4.7.1 Implications for implementing a multidimensional approach to RTW planning

Work rehabilitation for those with chronic (disabling) back pain encompasses multiple domains, including individual, occupational and environment modalities (Westmorland et al., 2002). This qualitative multiple case study sought to describe the phenomenon of interdisciplinary team discussion about the work environment domain only, taking into consideration the on-going rehabilitation process. As mentioned earlier, this particular focus is mainly explained by our large gap of knowledge on practitioners collaboratively involvement on real-life aspects of the work environment and its implications for appropriate RTW planning.

Many work environment dimensions within the 'person-environment interface' presented here correspond to predictors and factors identified previously by quantitative studies (Feuerstein et al., 1999; Krause et al., 2001a; Krause et al., 2001b). In particular, the 'individual factors' include many psychosocial job factors that have been recently identified as important targets for intervention. For instance, one study found that low job control and low control over work and rest (corresponding in this case to the category 'level of job autonomy') were associated

with a 30% decrease in the relative RTW rate, which might represent a large proportion of the total costs associated with LBD (Krause et al., 2001a). Comparisons between our findings and the current literature on predictors and RTW factors might provide new insights for disability management programs to identify which work environment targets could be further explored in practice, especially for improvements on interdisciplinary information exchange about key work factors.

A contributive comparison can also be made between the synopsis presented in Figure 4-3 and the well-known model of human occupation (MOHO), which provides a comprehensive theory related to the interaction person-environment (whereby the physical and social dimensions of the environment are considered). The application of this model to the RTW context is described elsewhere (Braveman, 1999; Kielhofner et al., 1999; Mentrup et al., 1999). In short, this model was developed in occupational therapy as one of its conceptual practice models. The MOHO considers that disability occurs because of an imbalance between the person and his/her environment and therefore implies that change must include altering the environment (Kielhofner, 2002). The analogy between the present study and the MOHO refers to the fact that both illustrate the multitude of factors related to work rehabilitation in a holistic way, emphasizing that the basis for an intervention is the interaction between a person and the environment. It is understood that the theory underpinning MOHO goes beyond what was addressed in this study; it is nevertheless clear that a parallel line exists and should be mentioned. As such, this study has empirically demonstrated – on the basis of a multiple case-study design – that the rehabilitation group at PREVICAP considers the holistic view of person-environment even while making clinical decisions on the intervention plan and procedures for the RTW.

Another commonly used model in rehabilitation is the Person-Environment-Occupation Model and it should also be mentioned here (Law et al., 1996). The PEO provides guidance to clinicians to implement interventions that go beyond the traditional functional restoration approach. The work environment and its dynamics are part of the PEO's framework and can be used as building blocks to guide workplace interventions. The findings from this study have in fact confirmed that rehabilitation practitioners are using such a comprehensive view of functioning

within environmental limits when it comes to workplace variables measured during the rehabilitation process. It is noted that the classification scheme contains dimensions already identified by the above mentioned (MOHO and PEO) and other RTW frameworks not discussed here; nonetheless this classification represents a pioneering exploration of information gathered direct from interdisciplinary group meetings, thus offering a rich source of data on aspects of real-life work rehabilitation phenomenon.

It is beyond the scope of this study to describe the relationship between the categories presented in the classification scheme, and given the multidimensional nature of many of the categories presented (e.g. 'self-efficacy towards work', 'work related stress', 'recognition and respect at work', among others) it would be an arduous and complex task. However, it was observed that the discussions of the issues related to the 'physical work and environment context', the 'organizational context', and the 'individual and job context' were interconnected with topics on the 'intervention context'. This is explained by the fact that the team discussed their observations and assessments related to the work environment (represented as 'person-environment interface' in the Figure 4-3) in order to determine possible courses of actions and proceed with workplace interventions when needed. The dimensions included in the 'person-environment interface' are in fact important determining factors for implementing work-oriented solutions because they are elements of the on-going assessment and observations processes carried out individually by each team member and later presented collectively. This idea is based on the assumption that multiple factors observed and assessed by the team influence the collaborative clinical reasoning process and affect the decision making on interventional strategies. Additional research similar to this one is needed to help contextualize the rationale for workplace interventions from an interdisciplinary rehabilitation perspective and to further explore the components identified here.

Furthermore, this study has provided new knowledge about the ergonomic components of a RTW program from an interdisciplinary information exchange activity, which has been little explored in the literature. For instance, the outcome categories related to ergonomic factors (such as 'exposure to vibration', 'production demands', 'level of mental workload', and others) may provide a starting point in

the identification of existing ergonomics assessment methods that could be useful in the rehabilitation context. It is clear up to now that the findings of many studies on ergonomic assessments – conducted largely independently from each other – have not reached the level of integration required to provide an unequivocal set of recommendations to rehabilitation settings and their clinical staff. Rehabilitation ergonomics, which is a domain in a phase of development, occurs in this interdisciplinary context. As such, there is an urgent need for comprehensive ergonomic evaluation models that consider the interdisciplinary engagement, as was investigated in this study. The results presented might be a good baseline for such a model. Currently efforts are underway to examine whether the identified ergonomic dimensions in terms of work demands may in fact be represented in a single ergonomic analysis method or a combination of existing methods, and to identify the pitfalls of existing methods during the work rehabilitation process. In light of the results presented here, we also posit the hypothesis that organizational dynamics and job-related personal factors (mainly psychosocial job factors) are equally important for RTW planning of individuals with LBD as knowledge of physical requirements of the job.

4.7.2 Implications for rehabilitation teams

The discussion topics reported here represent real life situations that most rehabilitation groups commonly have to deal with but are frequently studied in isolation due to their complexities and multidimensional level. Hence, the intensive examination and sharing of collected information on a case-by-case basis provides a compelling format to convey information on work environment issues from rehabilitation practitioners' perspectives to different stakeholders (i.e. employers, employees, insurance advocates, and others).

The lack of similar studies on information sharing during teamwork activities makes comparison with what has been presented here very difficult. To our knowledge, only one study has examined work rehabilitation group meetings (Jakobsson, 2002). Their focus was on the communicative pattern and group dynamics within two rehabilitation groups, rather than on the content of the information exchanged during the meetings. Their findings illustrate how close collaboration among actors

in rehabilitation may be organized. In parallel with this, the present study describes a multitude of work-related issues addressed by a rehabilitation group, providing insights as to the thematic nature of collaborative information sharing among team members. This form of collaborative information gathering by means of group meetings is informed by the concept of 'interdisciplinarity' and "what it means to work between disciplines" (Giacomini, 2004).

Independent of whichever models, bodies of knowledge or empirical tools each team member brings from their respective discipline, the research findings presented here reveal a comprehensive framework of work environment dimensions from a teamwork standpoint, which provides great motivation for further investigations on team's knowledge exchange and on how to achieve a shared understanding of the complex RTW approach. This signifies that each individual professional in the team might be able to identify their shared knowledge about the workplace situation and then identify which additional knowledge (from their own fieldwork) might be necessary to be shared among each other for better RTW planning strategies. This issue is particularly important for practitioners directly involved with workplace evaluations (in the case of PREVICAP, they are the occupational therapist and ergonomist). Further analysis to determine the importance/weight of the work environment variables presented in relation to the team's RTW plan would be necessary to devise more specific recommendations.

4.7.3 Methodological considerations

It is important to mention that most of the cases analyzed are representative of high-risk occupational populations of low back disorders, i.e. vehicle operators (truck and bus drivers, and railroad workers) and construction workers (laborers and material handlers) (Johanning, 2000). This is consistent with the PREVICAP program's main clientele at the time of the study.

The multiple case-study design employed in the study allowed the phenomenon studied to be extensively explored and represents experiences with clients within a particular rehabilitation setting closely linked to the workplace. The variability between cases could be considered as a contributing asset to the richness of the

findings presented and can be a significant beginning to a more in-depth qualitative research on teamwork collaboration and information sharing among the professionals involved (Miles & Huberman, 1994). Furthermore, the systematic approach used to verify data nomenclature and interpretations have ensured great accuracy and quality of the results and could be used by others investigating transcriptions of team interactions and dialogue. In specific, the steps described for the trustworthiness strategies are simple to follow and are well based on Guba's model for trustworthiness of qualitative research (Guba, 1981). Researchers in the field could benefit from using similar approach.

4.7.4 Study's limitations

Some methodological limitations are germane to the study and should be acknowledged. Firstly, this study consisted of a sole data source (verbatim from interdisciplinary meetings) and typically multiple sources of data are used in case studies (Stake, 1994). However, it is believed that each team member's reasoning is based on different axes of information gathering, such as communication with the worker (by formal means or during intervention procedures), observations and assessments done in the workplace, and networking with different stakeholders. This might suggest that the findings presented here reflect multi-level information processing from two angles: the 'multidisciplinarity' of the participants involved, and each member's reasoning based on different axes of information.

Another limitation relates to the dynamic nature of a communicative process (group meetings). The scheme presented here can only capture part of this dynamic (Figure 4-3). In reality, this represents a difficulty encountered rather than a limitation, because when one attempts to describe a complex phenomenon, intrinsic relationships and patterns can be lost even if the study follows a very rigid methodological approach.

Thirdly, when extracting information on just one component of a work rehabilitation process (the work environment), one does not consider the other elements of the process such as the worker's clinical response while being exposed to work, how he/she copes with the job accommodation, the support he/she receives from the

social environment outside work, etc. Often, these elements are heavily interconnected and are difficult to separate. In attempting to do this, information could be misinterpreted or lost.

The reader should also note that a limitation of the findings presented is that it concerns the discourse between only one group of stakeholders, the health care providers. Although the perspectives of other stakeholders such as the employer and the employee were not incorporated into the study's methodology, it is important to mention that their periodic feedback in the RTW planning is part of the rehabilitation mode of operation at PREVICAP. It may be relevant to explore further which work environment dimensions were indeed representative of the different group of stakeholders to avoid a reductionistic view of the disability phenomenon.

Lastly, the methodological nature of this study made impossible to determine which dimensions listed in Figure 4-3 were causally linked to the outcome and to which interventions these dimensions were related to. A factor analysis to weight these variables would be necessary to determine these relationships.

4.8 Conclusion

Scientific evidence suggests that a focus on the workplace and a better understanding of the interactions between person and environment might generate positive outcomes for the LBD problem and, in turn, costs can be potentially reduced (Dasinger et al., 2000; Loisel et al., 2001). The framework presented here highlights the most common aspects of work environment domain discussed by an interdisciplinary rehabilitation team, providing a synopsis of clinicians' involvement in the person-environment dynamic during a 'real-life' RTW process. It also illustrated the complexities inherent to a TRW program by describing and providing examples of a multitude of work environment issues related to the LBD paradigm, which in turn has helped contextualize the rational for planning workplace interventions (Figure 4-3).

The promotion of a successful and sustainable job accommodation for those with LBD depends on a team effort to identify areas in the work environment that could be better addressed during the rehabilitation process. The recognition of the

multidimensional nature of the LBD problem lends strong support to the adoption of an interdisciplinary approach, particularly when the team works in close collaboration with all other stakeholders involved, including the employer, the insurance advocate, the case manager, the attending physician and the worker. The present study has shed light on real-life work accommodation situations from the angle of the rehabilitation team, which hopefully will contribute to improve collaboration-actions between stakeholders.

By obtaining an integrated knowledge of work environment factors based on an interdisciplinary activity, practitioners may be in a better position to identify intervention models that fit within a cross-disciplinary framework necessary for moving this area forward in terms of scientifically sound RTW practices. Further investigation on teamwork collaboration and knowledge exchange between rehabilitation practitioners, especially when it comes to ergonomics disciplinary framework, is required to improve knowledge of disciplinary collaborations and how they can be optimized for the benefit of work rehabilitation outcomes.

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CHAPTER 5: STUDY II- DEFINING THE CONTENT AND UNDERSTANDING THE CHALLENGES OF THE ERGONOMIC EVALUATION FOR WORK REHABILITATION

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5.1 Abstract

Work system evaluations for the rehabilitation of low back disability (LBD) require consideration of the full spectrum of individual performance in a functional environment. The challenge in conducting such evaluations is integrating the results into the rehabilitation process while applying best practices and an interdisciplinary approach. Ergonomists working in this context need to better define their roles within rehabilitation teams and align their practices with evidence-based models. This study compares the content of ergonomic evaluations of LBD (as perceived and practiced by ergonomists) to a comprehensive work system model. It also identifies important issues regarding the process of conducting ergonomic evaluations within occupational rehabilitation field. Ergonomists and researchers alike might benefit from comparing the framework presented with current practice models in rehabilitation ergonomics. The findings presented may also facilitate an open dialogue between rehabilitation team members and other stakeholders.

5.2 Introduction

5.2.1 Background

Work absenteeism related to back pain, also referred to as low back disability (LBD), is costly and complex. Rehabilitation professionals continue to seek improved methods to effectively promote a successful return to work (RTW) for those presenting with disabling back pain (Frings-Dresen & Sluiter, 2003; Shaw & Feuerstein, 2004). A shift in the recommended approach to rehabilitation practices can be noticed today (Durand & Loisel, 2001a). In accordance with the "International Classification of Functioning (ICF) issued by the World Health Organization in 2001 and the most recent evidence on work disability prevention, rehabilitation professionals are asked to address this problem beyond the use of medical care or traditional physical rehabilitation models (Staal et al., 2002; Stucki et al., 2002, Adams et al., 2006; Kuijer et al., 2006b). An emphasis on work modifications and the work environment as key components of rehabilitation, as well as the provision of a proactive interdisciplinary approach that offers both clinical and occupational interventions, are some of the major changes observed in

many rehabilitation practices today (Hochstenbach, 2000; Loisel et al., 2003; Waddell & Burton, 2005).

Following these changes, ergonomists working in contemporary rehabilitation/RTW programs are increasingly challenged to apply their knowledge of work systems to reduce the burden of LBD and associated costs. The application of ergonomics to secondary and tertiary prevention of work disability is not a new strategy (North & Rohmert, 1981; Abdel-Moty et al., 1988; Isernhagen et al., 1997). However, this topic has been gaining more attention as new studies demonstrate more accurate information on the impact that many work-related factors have on musculoskeletal disability outcomes (Friesen et al., 2001; Feuerstein et al., 2001; Baril et al., 2003; Guzman et al., 2007a; 2007b). Many of these studies are qualitative and interdisciplinary in nature, conducted by researchers from such diverse fields as industrial psychology, sociology, engineering, sociology, environmental science, business administration, nursing, ergonomics, and rehabilitation medicine. One example is the study by Baril et al. (2003). After analyzing RTW programs in various Canadian sites, they described how certain workplace dynamics – mainly organizational aspects – may facilitate or hinder RTW for persons with musculoskeletal disorders. Many other qualitative studies have provided information on different stakeholders' perspectives, interests, needs and incentives, thus clarifying essential aspects of the often complex musculoskeletal disability phenomenon (Westmorland et al., 2002; Larsson & Gard, 2003; Loisel et al., 2004).

This plethora of information coming from various disciplines led many authors to agree that ergonomists should look beyond the simple identification of physical risk factors when it comes to musculoskeletal pain and work participation (Marras, 2000; Shoaf et al., 2000; Cole et al., 2003; Tuncel et al., 2008). Recently, several studies have promoted the idea of adopting a comprehensive ergonomics paradigm when dealing with musculoskeletal disorders in the workplace (Shoaf et al., 2000; Tuncel et al., 2008). Although ergonomists working in rehabilitation/RTW programs have been actively encouraged (i.e. via the professional literature) to incorporate a more global ergonomic approach into their practice, it is not known if this recommendation is being followed in practice. Recently, Leyshon and Shaw (2008) point out that many studies in this field describe ergonomic interventions in a very

specific manner (e.g. the design of a new computer keyboard), but rarely do they mention a global systems approach (Leyshon & Shaw, 2008).

Evaluating the myriad work dimensions pertinent to musculoskeletal disability is a complex and difficult task both in terms of the evaluation process and its content. From a practice perspective, one difficulty ergonomists may face is gathering, on an individual basis, valid information from an often-intricate work environment while accounting for the utility of this information in the rehabilitation/RTW process. From a research perspective, the lack of a scientifically recognized ergonomic practice model (or models) for rehabilitation/RTW makes it difficult to define the role ergonomists are playing in terms of their particular contributions (Costa-Black et al., 2007; Leyshon & Shaw, 2008). Furthermore, considering the required level of information exchange on the various aspects of the disability problem, ergonomists working in rehabilitation/RTW programs need to better define their role within rehabilitation teams, in an effort to bring their practices closer to evidence-based models.

Moreover, appropriate professional collaboration and communication are essential to effective disability management (Tollison & Kriegel, 1989; Rice, 1998; Pransky et al., 2004). Pransky et al. (2004) highlighted the importance of effective communication processes and documentation in disability prevention: "as to enable researchers to identify concepts and methods that transcend disciplines and models". They explain that the focus on the communication process among stakeholders, for instance, may serve to determine the effectiveness of the disability management model implemented (Pransky et al., 2004). Tollison and Kriegel (1989) when discussing interdisciplinary collaboration in rehabilitation of low back pain, emphasize that each team member should adopt a common philosophy of disability management and should act as part of a "functional unit whose members are willing to learn from each other and modify, when appropriate, their own opinions based on the combined observations and expertise of the entire team." Although different in scope, both studies (Tollison & Kriegel, 1989; Pransky et al., 2004) reinforce the idea that ergonomists working in rehabilitation/RTW programs must clarify their professional role for proper team collaboration and effective communication.

In addition, the client-centred scenario in rehabilitation may differ from other ergonomic practice models such as primary prevention practices for specific population groups or product design. This may explain why many ergonomists working in this field are rehabilitation professionals themselves. Regardless of their professional background, ergonomists are encouraged to apply the main principles of ergonomics (i.e. health, safety and efficiency) when evaluating the work situation of persons with musculoskeletal disorders (Dempsey et al., 2000). These principles aim to achieve optimum functionality of the human-at-work system while addressing both the well being of individuals and of organizations (Wilson & Corlett, 1995). This system perspective is considered very important when collecting and utilizing information for each worker uniquely affected by a multi-factorial disability phenomenon (Khalil et al., 1999). At present very little has been documented about this client-centred practice, especially as it relates to the evaluation process and content for the rehabilitation/RTW of low back disability cases (Staal et al., 2002).

In light of this lack of knowledge of ergonomics practice in rehabilitation, this study proposes to explore the content of ergonomic evaluations for LBD cases considering the rehabilitation context described above. Because ergonomists are in the best position to impart details of the work system which are important to their rehabilitation practices, this research is based on the experiences reported by practitioners in the field. Thus, two research questions are related to this objective:

1. Which particular work-related variables are taken into consideration by ergonomists working in rehabilitation/RTW programs?; and
2. How are these concepts related to the main elements of a conceptual model the elements of a conceptual model that guides a complete work system evaluation?

5.2.2 Literature review

The precise role and scope of ergonomics (i.e., safety, comfort and efficiency) have been not clearly defined in contemporary workplace-centred rehabilitation programs. Not only this is a new field of research development but also the complexity of the disability phenomenon makes it difficult for researchers to overcome the many methodological challenges (Snook, 2005). Few publications

cover this subject and they can be classified into two main categories: 1) publications that describe a job-match or a client-centred ecological approach (Halpern, 1992; Matheson et al., 1997; Khalil et al., 1999; Armstrong et al., 2001); and 2) research on RTW interventions primarily using an ergonomics participatory approach (Loisel et al., 2001; Anema et al., 2003). The most cited strategy used in rehabilitation is the job-match model. Armstrong et al. (2001) clarified the components for job analysis necessary for this approach, including the use of database systems available to the public such as the DOT (Dictionary of Occupational Tittles) and ONET (Occupational Information Network). For jobs that can be easily partitioned into specific physical ability requirements, the application of this model seems to be useful, as demonstrated in the two case studies presented by Armstrong et al. (2001). One of the main problems with this approach is its credibility, given that pre-established assumptions are made when measuring worker's functional capacity and then comparing them with job demands (Pransky et al., 2004). Another issue is that the multidimensional nature of the disability problem may not be captured when using this approach and interpretation of findings can be misleading. For instance, social work dynamics are not considered in this approach, however such workplace context is considered critical to rehabilitation outcomes (Muenchberger et al., 2008).

Recently, one study has proposed the use of the ICF as a conceptual model for rehabilitation ergonomics (Leyshon & Sham, 2008). The ICF has been largely discussed in the literature and it may represent a road map to bring ergonomic practices closer to rehabilitation models. It also has the potential of promoting transdisciplinarity for work disability prevention since it promotes the use of a common language among the different professionals involved in the disability phenomenon. Despite recent research development on practical use of the ICF, more studies are necessary: 1) to determine how it can offer the basis for ergonomics interventions in occupational rehabilitation/RTW in practice; and 2) to examine the specific areas covered by ergonomics but that have not yet been captured in the ICF (Heerkens et al., 2004; Leyshon & Sham, 2008).

There are other publications in the domain of rehabilitation ergonomics; however, they are outside the scope of this study either because they specifically cover

musculoskeletal disability related to neck and/or upper extremity disorders (Armstrong et al., 1993), or they focus on ergonomics for people with permanent or semi-permanent mental and physical impairments (Nowak, 1999; Kumar, 2001).

5.2.3 Main information on the model retained

One single model may not be sufficient to study the dynamics of the work environments, which give rise to the multidimensional disability phenomenon (Faucett, 2005). Nevertheless, it was necessary to select a particular model to serve as a theoretical orientation for this study. The WCM was chosen for this purpose, primarily because of its superior level of detail compared against other models (Abdallah et al., 2004; Genaidy et al., 2002; 2005; 2007a; 2007b; 2008). The framework that serves as the basis for this model has been developed for various purposes including the design of rehabilitation and RTW programs (Shoaf et al., 2000). The authors of this framework suggest that it could be used by rehabilitation professionals to analyze the work system in an effort to identify tasks which are essential for job execution. Performance criteria of these tasks are established in terms of worker's capability to RTW (Shoaf et al., 2000). In addition, this model offers a very promising –although quite complex – methodology to improve human performance in the workplace.

The WCM has two basic premises: 1) the synergistic effects of the full spectrum of work factors upon performance of individuals in the workplace must be considered; and 2) the work system elements must be balanced in order to optimize all human performance measures in the workplace (Genaidy et al., 2002). Based on these premises, the model characterizes work-related factors as elements that interact with the person in question, simultaneously drawing and providing energy to the human-at-work system; the authors call it "energy expenditure" and "energy replenishment" (Genaidy et al., 2002). By using the term simultaneous effect, they imply that a factor such as time pressure can be seen as a demand if it results in stress or as an energizer when stress motivates people to perform better. In analyzing all these variables present in the work system, it is possible to define the degree of equilibrium between energy expenditure and replenishment forces in the workplace, as they vary between individuals.

The notion of 'energizers' versus 'demands' is essential for understanding the construct of Work Compatibility (WC). WC is defined as a work design parameter, which expresses the level of energy as a balance between expenditure and replenishment. Productivity and health are based on the integration of all parameters of the work system. The energizers (i.e., a positive impact on human energy) and demands (i.e., negative impact on human energy) are the WC system inputs (Abdallah et al., 2004). Genaidy and co-workers then separate WC into two types: "acting compatibility" (i.e., all factors emanating from the work tasks and environment acting upon the individual), and "experienced compatibility" (i.e., all factors experienced by the individual in the work system which are the products of variables 'acting on' the individual and his/her personal characteristics). Eight domains comprise 'acting compatibility': organizational environment, technological environment, physical environment, economic growth, individual growth, social and communication environment, mental task content and physical task content. Four domains represent the 'experienced compatibility' group: effort, perceived risk/benefit, performance and psychological impact. Each domain is explained in Appendix A; however, the reader should refer to the published literature for more detailed information (Abdallah et al., 2004; Genaidy et al., 2002; 2005; 2007a; 2007b; 2008).

5.3 Method

The current study was conducted within a larger project entitled "Ergonomics in the rehabilitation of low back disability cases: towards development of an evaluation framework that fosters team collaboration" (Costa-Black, 2008). Considering the character of the two research questions mentioned earlier, this study is both descriptive and exploratory (Trudel et al., 2007). A two-step content analysis method involving an expert consensus and a deductive thematic analysis will be described.

Figure 5-1 represents an adaptation of Krippendorff's framework of content analysis (Krippendorff, 2004). It illustrates the methodological framework used including the conceptualization of the research questions in relation to the data analysis procedures (i.e. steps 1 and 2) and respective analytical constructs (rounded

rectangles). Step 1 was the analysis of a group consensus in order to address the first research question. Step 2 was a deductive categorical analysis to explore the connection between the elements derived a priori from a model and the data obtained from the consensus in Step 1 (i.e. research question 2). Two distinct analytical constructs are part of this study's conceptualization. The first is the work environment dimensions from an interdisciplinary perspective – obtained from a study conducted previously by members of our research group (Costa-Black et al., 2007). It presents a template of factors related to the human-at-work system (also referred as "the work environment dimensions") of ten LBD cases enrolled in an evidence-based work rehabilitation program. Although this information represented a multi-professional engagement in the work system (it was extracted from interdisciplinary team meetings), it allows the identification of the elements which the ergonomist might be qualified to intervene and which are part of the rehabilitation/RTW decision-making process.

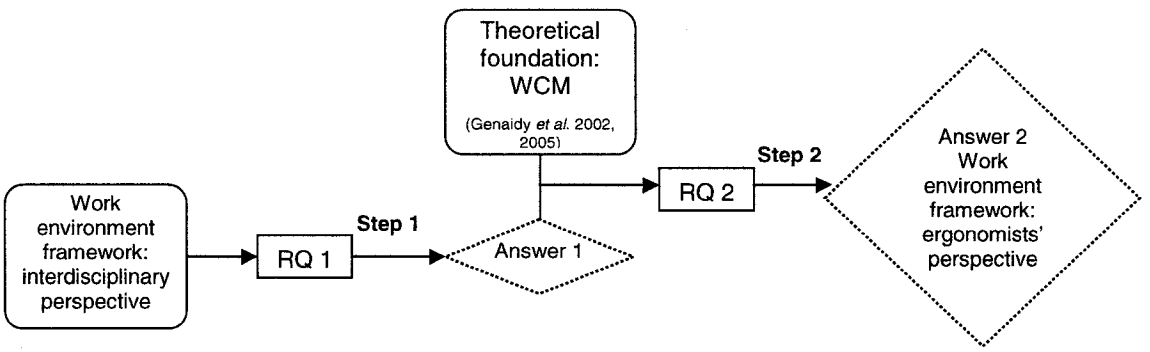


Figure 5-1: Schematic representation of the steps, research questions and analytical constructs related to the study's conceptualization (adapted from Krippendorff, 2004)

The other analytical construct, related to the second research question, is a comprehensive conceptual model applied in industrial ergonomics. The WCM, described earlier, served as both empirical and theoretical foundation for studying the human-at-work system from the ergonomist's perspective. Both these

constructs are the main theoretical foundations which connect this study's empirical data to the answers it hopes to provide (Krippendorff, 2004).

5.3.1 Participants

The participants for this study were selected according to a purposeful and criterion-based method in line with our research questions (Creswell, 1998). The main goal for the purposeful selection, also known as 'purposeful sampling', was to capture the heterogeneity in the study group thus ensuring that the findings adequately represent an entire range rather than only typical members (Creswell, 1998). The heterogeneity of the group was also important for the type of consensus technique employed (Gill & Delbecq, 1982).

The criteria for selection was as follows: 1) experience in conducting ergonomic evaluations for rehabilitation/RTW purpose for a minimum of 2 years; 2) experience working as a rehabilitation team member for a minimum of 2 years; and 3) the clientele of the person selected should have mainly consisted of workers seeking care for musculoskeletal disability in a secondary or tertiary prevention capacity.

In order to find ergonomists with this profile, rehabilitation centers in Quebec (metropolitan Montreal) were identified using the World Wide Web. We contacted the ergonomists at these centers as well as members of a professional network in Quebec called REPAR (Quebec Rehabilitation Research Network). Twelve eligible persons were eventually asked to participate, of which six declined and one dropped out in the middle of the study due to lack of time. The final number of participants was five, which was considered an appropriate number for the utilization of the group consensus technique employed (Gill & Delbecq, 1982).

Table 5-1 summarizes the main characteristics of each participant. At the time of the study, all five ergonomists selected assisted more often with workers' compensation cases than with clients with private insurance. The study group consisted of both women and men.

Table 5-1: Main characteristics of the participants

Characteristics of participants	*E1*	*E2*	*E3*	*E4*	*E5*
Experience conducting ergonomic assessments	4 years	5 years	11 years	20 years	5 years
Experience in rehab./ teamwork	2 years	2 years	15 years	8 years	5 years
Disciplinary background in addition to ergonomics	Kinesiology	Exercise physiology	Occup. therapy	Environ. Biology	Environ. Health
Ergonomics educational training	Master degree	Master degree	DESS*	DESS*	Master degree

* In Quebec, DESS (diplôme d'études superiéures spécialisées) is a post-graduate professional degree similar to a masters but without research requirements.

5.3.2 Procedures

A formal consensus technique, called the Nominal Group Technique (NGT), was employed. NGT is mainly used to generate a rank-ordered list of ideas from relevant experts about a given issue (Gill & Delbecq, 1982). Advantages of this technique have been reported in the literature and include, among others: the final consensus can be reached more quickly; everyone in the group has equal opportunity to present their ideas; less face-to-face interaction is required in comparison with the Delphi method; and it is more structured than a focus group while still taking advantage of the synergy created by a group meeting (Potter et al., 2004).

The detailed steps for the application of this technique are described elsewhere (Allen et al., 2004). In summary, members were brought together for a discussion session led by a moderator; after the topic has been presented to them, they had the opportunity to ask questions or briefly discuss the scope of the topic. They are then asked to take a few minutes to consider what they feel are the most important issues and write down their responses individually. Next, the session moderator asked each participant to read and elaborate on the list of work factors in a group setting. Session participants were then asked to rank work factors according to their relative importance. These rankings were collected from all participants and then aggregated (first round); second and third rounds follow until a consensus

decision was reached on a group of work factors (Allen et al., 2004). An adapted version was used in which a first contact was made via electronic mail for presenting and discussing the topic. Promising reports exist in the literature on the use of this mode of communication in research, and specific protocols for internet research were followed (Michalak & Szabo, 1998; Snyder-Halpern et al., 2000). As part of preparation for the face-to-face meeting, the template created by Costa-Black et al. (2007) was sent electronically, together with a few related questions. Sending this information on possible factors to consider a priori the meeting was a necessary step to assure that the group would have a frame of refence to discuss in the meeting. The template also helped them to discuss the work factors by groups which facilitated to envision the priorities for the ergonomic evaluation set in practice. The participants also received written information on the aims and procedures of the study.

A face-to-face meeting took place during the fall of 2006 at the Bombardier Pavilion, University of Montreal, Canada. Data collection tools used for this study included a computer, field notes and a digital audio recorder. The group had a moderator with experience in various types of group consensus and an assistant moderator (a research assistant) to guide the discussion and to encourage all members to participate equally and express their own views on the topic. The discussion concentrated on the following key question: 'which are the work variables that YOU take into consideration in your ergonomic evaluation process for the rehabilitation/RTW of workers with LBD?' The template of all work variables discussed by an interdisciplinary team during the rehabilitation/RTW of LBD cases was again used as orientation for the discussion with the ergonomists (Costa-Black et al., 2007). The template assists in identifying the content of ergonomic evaluations from an interdisciplinary activity. Although it amply covers the work environment, participants were encouraged to add factors not included in the template, however judged necessary for the ergonomic evaluation. As a way to better understand the context of each factor mentioned, the moderator encouraged the participants to clarify not only what they meant regarding a particular work factor, but also how and why they thought it was important. At the end of the

session, a formal consensus was reached and a final list was created of work variables considered important to the ergonomics evaluation of LBD cases.

The study was approved by the Ecole Polytechnique Research Ethics Committee (CER-05/06-12). The participants signed a consent form at the time of the study according to the rules and recommendations of Polytechnique's REC. Confidentiality of all information provided by session participants was guaranteed by formal letter. It was also made clear that their participation was voluntary and participants could refuse to answer any question at any time.

5.3.3 Analysis

According to Krippendorff (2004), a content analysis is a technique for making replicable and valid inferences from texts to the contexts of their use. As shown in Figure 5-1, a two-step analysis was employed to address the two research questions of the study. The steps are described below.

Step 1: Group consensus analysis

As mentioned before, a final list of work factors was generated at the time of the meeting. The participants ranked the factors by the importance to the ergonomic evaluation in the rehabilitation/RTW of workers presenting LBD. The analysis of the qualitative data was carried out at a later stage. The audio recorded group session was transcribed verbatim and analyzed by the principal investigator. This analysis was carried out using mainly an inductive qualitative text analysis method (Miles & Huberman, 1994; Mayring, 2000). To become familiar with and to understand the content of the material in its overall context, the analyst first listened to the audio files several times before beginning the exploratory text analysis (Miles & Huberman, 1994). It was important for the next step of the analysis (i.e. step 2) that the work factors identified via consensus were clearly understood and reflected the work rehabilitation context described by the study's participants. Appendix B provides a summary of each item. These descriptions were originally obtained from earlier interdisciplinary discussions (Costa-Black et al., 2007); however most items were revised during the NGT and new items were added according to the participants' description (by analysing the verbatim extracted from the NGT

meeting). The goal was to capture how the ergonomists understood and described each factor in order to ensure that the analysis preserved these specifications.

Given the exploratory nature of the verbatim analysis of the group meeting, the analyst (i.e. principal investigator) had opportunity to identify from the ergonomists' discourses, a few challenges that they face in the ergonomic evaluation process for rehabilitation purpose. According to the data analysis approach adopted, while analysing the description of each work factor in the verbatim, the analyst's conceptual contributions in generating hypotheses based on data must be acknowledged (Krippendorff, 2004). The challenges described by the participants are presented in the results session.

Step 2: Deductive thematic analysis

Categories of analysis were determined a priori based on the main elements of the WCM. This is a procedure described in the literature as a deductive analysis process, i.e. the definitions of the categories are based on an existing theory (Landry, 2003). In the deductive process proposed by Landry (2003), it is important to follow three criteria for obtaining quality in textual analysis: 1) mutual exclusion (i.e., one observed unit of analysis should only represent one category); 2) reliability (i.e., different people should classify the text in the same manner); and 3) pertinence (i.e., the categories should be adapted to the data and to the theoretical and empirical objectives of the researcher) (Landry, 2003). During the analysis, close attention was paid to these three criteria. In order to check inter-rater reliability, a codebook containing a description of each element of the WCM was created using descriptions found in the literature (Shoaf et al., 2000; Genaidy et al., 2007a; 2007b). The descriptions of the WCM elements (presented on Appendix A) together with a few code rules were sent to two independent raters (second and third authors of this manuscript). The principal investigator asked the raters to code the summarized data presented in Appendix B. Few diverging results were found and these were resolved in follow-up meetings (Landry, 2003). In a few items in which the agreement was not satisfactory initially, the principal investigator searched the transcribed verbatim for further description. Once they were clarified a final agreement was reached on all items.

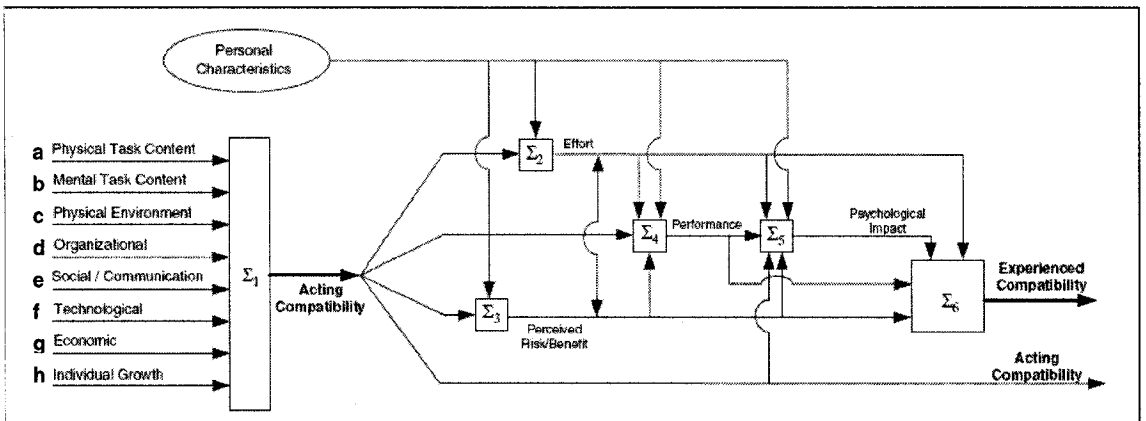
5.4 Results

5.4.1 The content of ergonomic evaluations

Figure 5-2 presents the convergence of the ergonomists' consensus on work variables pertinent to their evaluations of LBD cases by elements of the WCM. Appendices A and B describe all work factors listed in this figure, i.e. the elements of the WCM and the work factors deemed important by the ergonomists. The top diagram outlines the inter-relationships among the main work system variables according to the WCM main structure (Genaidy et al., 2005). It is beyond the purpose of this study to examine these relationships with regards to the data obtained from the consensus group.

Participants identified by consensus a large range of factors that fall within most subgroups denominated 'acting compatibility' factors (Σ_1). As expected, 'physical task content' appears to be the topic most covered, followed by 'social/communication environment'. In the latter, the participants agreed about the importance of various issues related to workplace conflict, support and praise. Two work factors in this subgroup, however, may represent particularities to rehabilitation practice: 'employer flexibility regarding the RTW' and 'workplace receptivity'. Participants revealed in the meeting that the welcoming structure and atmosphere in the workplace are indeed essential not only for determining work accommodation options such as the possibility for job modifications, but also for gathering data at the workplace.

Interestingly, only a few factors related to the environment surrounding the workstation (i.e., subgroup 'physical environment') appeared important to the ergonomists. Present in the WCM but not included in this subgroup are issues related to fall hazards, temperature, confining space and air quality. These aspects of the physical environment were not relevant to rehabilitation/RTW according to the ergonomists' experience. This can be explained by the specific and case-sensitive rehabilitation/RTW context in which the workplace must be evaluated.



Acting compatibility (Σ1)	**a** MH demands– level MH demands- lifting charact MH demands- time MH demands- type Postural demands- time Postural demands- type Repetitive motion - time Repetitive motion - type Working posture descript. **b** Level of mental workload Level of task complex. **c** Exposure to vibration– level Exposure to vibration- time Exposure to vibration– type Floor condition Safety issues (use of PPE) Workplace layout	**d** Business type Company/employer's size Commitment to H&S Corporate culture Frequency of the task Job content Job title Level of job rotation Pace required in the job Production demands Recovery time Self-regulation RE w. breaks Task(s) performed Time in each task Union involvement in the RTW Work schedule Work season Work shift	**e** Employer acceptance of erg. interv. Employer flexibility RE the RTW Relationship w/ co-worker Relationship w/ employer Relationship w/ supervisor Teamwork structure Workplace receptivity **f** Safety issues (adequacy of equip.) Seating characteristics Skill demands - level Skill demands - type Vehicle characteristics Working tools - design charact. Working tools - time Working tools - type **g** Financial issues of the company **h** Job certification	
Exp. compatibility (Σ6)	Σ_2 Level of physical fatigue Perceived effort Perceived mental demands Physical capacity	Σ_3 ?	Σ_4 Level of task difficulty Pace of task performance Work related stress	Σ_5 ?
Personal chact.	Anthropometric issues Goals & preferences regarding RTW Nature of work accident Readiness to RTW Work experience in field Work technique			

Figure 5-2: Framework of work system variables pertinent to rehabilitation according to the convergence of the WCM (top diagram) with ergonomists' consensus.

However, future studies should examine this issue more closely. In the 'organizational environment', the factors identified by ergonomists are close in scope to what the WCM describes, with the exception of issues such as task meaningfulness and division of labour. Task meaningfulness might be an important issue in rehabilitation as it may impact the worker's level of satisfaction and motivation to perform his/her job. Two factors classified under 'organizational environment' are particular to the rehabilitation process: 'self-regulation regarding work breaks' and 'union involvement in the RTW'. The former is very close in concept to the adequacy of rest-allowances as described in the WCM, however self-regulation implies a characteristic of an individual influenced by the level of autonomy given by the organization, whereas the other (i.e. 'union involvement in RTW') refers to the organization's authority and time management. The findings on the organizational environment in general show that many factors discussed in the scientific literature are in fact taken into consideration in practice according to the study's participants.

The 'technological environment' subgroup contains several factors related to hardware. However, only two were identified as 'human capital': skill demands type and level. Work factors such as job training, technical supervision and expertise, as described in the WCM (see Appendix A item 'technological environment'), are likely to be relevant to job accommodation options. Researchers should explore this issue in order that more specific recommendations can be drawn for this type of practice. In 'mental task content', only two work variables appeared to play a role on the ergonomic evaluation of LBD according to study's participants: 'level of mental workload' and 'level of task complexity'. It is possible that the jobs they had evaluated thus far were primordially manual, for which mental tasks are not essential elements. The literature reports high incidences of musculoskeletal disability cases among manual jobs where the mental demands might be considered an important limiting factor such as in the case of nurses. The WCM suggests a work system analysis view whereby a range of cognitive, sensory and information processing issues are included, whether or not they impact work performance. This should also be explored in future studies since it is uncertain the role mental task content play on the RTW process for individuals with LBD.

With regard to 'economic growth', only 'financial issues of the company' was identified as relevant to the ergonomic evaluation. In both the WCM and in the description of this item by the ergonomists (Appendix B) the focus was on financial issues that directly affect the worker's job such as monetary incentives, promotion, bonuses and job security. Contrary to the expectation, these issues were not identified as important with regards to possible work reassignment and accommodation options for workers with musculoskeletal disabilities. The concept of 'individual growth' as described in the WCM involves not only the development or utilization of knowledge but also skills and adoption of innovations. Ergonomists only identified 'job certification' as pertinent to rehabilitation. Possibly the other factors related to 'individual growth' in the WCM go beyond what is assigned to the ergonomist in rehabilitation, as it might be a subject for human resources personnel.

In the domain of 'experienced compatibility' (Σ_6), no factors were identified as related to 'perceived risk/benefit' (Σ_3) and 'psychological impact' (Σ_5). Given the interdisciplinary nature of information exchanged in rehabilitation, it is possible that issues related to individual wellness – such as the fear of getting injured or re-injured and other psychosocial factors – might have been addressed by another professional in the team, such as the psychologist or the occupational therapist. The same applies to worker satisfaction and his/her level of motivation. According to text analysis, participants did not consider these issues important to the ergonomic evaluation process. However, they all agreed that psychosocial work factors are very important in the overall integration of data in rehabilitation/RTW. The 'perceived effort' of work (Σ_2) was characterized by variables related to both mental and physical workload, which is consistent with the description of this concept in the WCM literature. In the work 'performance' subgroup (Σ_4), factors related to achieving job goals/expectations also seemed conceptually linked to the main description of performance presented in the WCM; however, participants did not specify any issue related to the amount and quality of work output or work safety guidelines. These specifications might be particular to the WCM applications (i.e. manufacturing and service industry); although in some cases they could be also relevant in rehabilitation depending on the job type one needs to evaluate.

Finally, several personal characteristics related to work, and in particular to rehabilitation/RTW, were identified by the participants, among them: 'goals and preferences regarding RTW'; 'nature of work accident'; 'readiness to RTW'; and "work technique'.

5.4.2 Challenges to evaluation process

While exploring the content of the ergonomic evaluation, the participants identified three important challenges they face when integrating this information into the rehabilitation process. The challenges presented here are part of the evaluation process and can impact ergonomists' decisions on the overall content and structure of workplace evaluations.

Source of data

One important issue that emerged in the discussions was the interdisciplinary exchange of information. Participants highlighted that although the factors they have chosen are important variables for the ergonomic evaluation, they are not necessarily work variables assessed by them. In fact, some variables presented in Figure 5-2 might represent an interdisciplinary overlap of information, rather than an item brought to the team exclusively by the ergonomist. The following discussion excerpted from two of the participants illustrates this point:

> "A: As a general rule in rehabilitation, I think that when we conduct an ergonomic evaluation, the ergonomist does a little of "occupational therapy" and the occupational therapist does a little of "ergonomics"; the same applies for the intervention.
>
> B: Yes, there are parts which are a little bit exclusive but there is a large overlap."

In particular, they explained that a physical capacity performance test usually done by either the occupational therapist or the physical therapist in their team is a very important piece of information which often guides their decisions on whether to collect precise data on certain physically demanding tasks. One of the participants who had a background in both occupational therapy and ergonomics reported that

she was responsible for bringing information on functional limitations to the team in addition to physical work demands. All other participants said the 'physical capacity' measures were obtained by other team members. Because of their belief that functional limitations are usually not measured in real working conditions (although some are considered job-specific), they often discussed their data with the occupational therapist or physical therapist in the team to avoid any misunderstandings both in relation to the actual risk present in the job and the capabilities of the worker to perform a task. This type of close collaboration between rehabilitation professionals is often promoted in theory and in practice when it comes to evidence-based rehabilitation programs. This informal and more subjective procedure to exchange data may differ from job-match models that promote a formal matching of workers' limitations with job demands mainly based on objective data obtained by one or two professionals. Comparative studies of different procedures done in rehabilitation to combined data may help determine which one, i.e. informal communication among professionals versus formal job-matching approach, can generate more effective RTW solutions. Studies on the role of a RTW coordinator may also help elucidate the best approach for data gathering and integration in rehabilitation.

Furthermore, participants revealed that the results of the functional capacity evaluations can sometimes generate ambiguity in relation to job requirements. In this situation, they might need to obtain more specific information on the parameters of the job. In spite of this, they all considered 'physical capacity' as one of the most important issues that influence the ergonomic evaluation process and its goals. When a worker brings prior information on his/her functional capacity (i.e., before engaging in the rehabilitation program) the scope of the ergonomic evaluation is also shaped by information on job demands that is missing or is ambiguous. These findings highlight the importance of designing flexible ergonomic evaluation processes – or even a practice model – that integrate, on a case-by-case, different information needs and clinical utility.

The source of the request for evaluation

Another issue that emerged from the text analysis and which impacts decisions on the scope of the ergonomic evaluation was the nature of the request for the evaluation. For the ergonomists, the importance in considering each of the factors presented in Figure 5-2 varies not only for each client and work environment, but also with the nature of the demand for an evaluation, especially when there are legal implications in the case. According to them, when compensation is determined according to the nature and severity of the injury or accident, it might shape the evaluation process. For instance, if they received a request which indicates the specific work factors that contributed to the injury or aggravates the worker's condition; these are considered priority factors in their workplace evaluation. This information would usually come from the worker's compensation report prior enrolment in the rehabilitation program. When the request has no legal ramifications, the starting point is what the worker initially reports as work demands (i.e., perceived physical, mental, emotional or cognitive demands). It is essential that any professional involved in the identification of work factors be aware of his/her impact on the legal situation or determination of compensation benefits. Researchers investigating rehabilitation ergonomics are encouraged to raise questions to generate knowledge on the possible impact of the work evaluations in aggravating the disability phenomenon.

The employment status of the worker

The third challenge impacts mainly the evaluation's structure, rather than its content. It refers to how the ergonomic evaluation is done when the worker is away from the work environment, either because he/she is on sick leave (according to participants this is often the case) or because the ergonomist is required to evaluate new tasks. When the worker is absent from the environment and his/her work situation needs to be evaluated, the ergonomist relies on information from different sources. For instance, one ergonomist mentioned that she observes another worker doing the same job, talks at length about the task with the worker in person or over the phone, and speaks with union representatives and supervisors. In this situation, once the worker is reintegrated back to work, several follow-up workplace visits are

essential to ensure that his/her operational working procedures are appropriate and the risk of re-injury has been reduced or eliminated. This finding reinforces the need for flexible ergonomic evaluation models that can account for the work status of the worker and his/her availability to be in-site when workplace evaluations are taking place.

5.5 Discussion

Strong evidence exists now showing that a proactive rehabilitation in the workplace is the most effective strategy for chronic and disabling back pain (Cole et al., 2003). Although there is large evidence on strategies to prevent and manage work-related back pain and absenteeism, the personal and financial costs as well as human suffering associated with this condition are still on the rise (Chibnall et al., 2000). It is therefore of utmost importance to improve current rehabilitation practices by using evidence-based models with strong practical value. This study is part of a practice-to-research effort: an attempt to bring the issues dealt by ergonomists in practice closer to a conceptual model. According to various evidence-based practice models, the inclusion of practitioners' expertise and practice in an early stage of research development is crucial in ensuring the relevance of the research and it may facilitate the translation of knowledge into practice (Rosswurm & Larrabee, 1999; Nutley et al., 2003). The results presented here can provide a starting point for understanding the body of knowledge utilized by ergonomists in practice, which up until now has been very little explored.

5.5.1 Implications of findings

Ergonomics methodology has been practiced in rehabilitation programs centred in the workplace for quite some time; however, only recently it begun to receive more attention in the literature (Leyshon & Shaw, 2008). While work reintegration is typically individualized for each employee, ergonomists would benefit from defining the fundamental structure of their workplace evaluations in LBD cases in order to effectively document and share this information with the other rehabilitation team members. The thematic organization of the work system variables presented in Figure 5-2 may provide a start in this regard, and could encourage ergonomists to

shape their current practices. The structured information on factors that ergonomists target in practice can facilitate not only the communication with rehabilitation professionals but also with other stakeholders. Such open dialogue among all involved in the disability problem is vital to making informed decisions about workplace interventions (Guzman et al., 2007b).

According to the work disability literature, it is unlikely that any professional that targets one specific domain of risk factors will reduce the burden of disabling back pain (Cieza et al., 2004). The identification of work factors related to rehabilitation/RTW in an integrated manner as presented in Figure 5-2 provides an overview of ergonomic practice in rehabilitation. According to this figure, ergonomists working in a teamwork environment seem to have adopted a comprehensive approach in their own practice, or at least one that covers most of the facets of the human-at-work system, including organizational factors. This shows that a reasonable bridge exists between practice and research. Still, the comprehensive perspective offered by the WCM goes beyond what ergonomists do in rehabilitation. For instance, no factors related to 'psychological impact' and 'perceived risk/benefit' factors were identified by participants. Similar research is necessary to generate cumulative knowledge on the boundaries of ergonomic practices in rehabilitation in relation to a specific rehabilitation/RTW model. An effort in this direction has been made recently by Leyshon and Shaw (2008). They propose the use of the ICF as model to guide rehabilitation ergonomic practices.

Moreover, our findings suggest that the cross-disciplinary exchange of information should be better defined in future studies. It is important to confirm if elements that might be responsible to balance work system functionality such as 'psychological impact' and 'perceived risk/benefit' are not missed and are in fact targeted by another professional in the rehabilitation team. Better understanding of each professional disciplinary framework is certainly necessary for the type of professional collaboration that prevention of work disability requires. For instance, the ergonomists in our study indicated that a few work factors that are important in the RTW process and to the ergonomic evaluation itself are gathered by the occupational therapist in the team. It is difficult to define precisely the content of ergonomic evaluations because the evaluation of work systems is oriented by

various discipline-specific frameworks. Drawing more specific recommendations on the content of interdisciplinary exchange will avoid duplicate effort in collecting data about the work system. Future ergonomic studies should consider both the interdisciplinary engagement (with regards to its process) and cross-disciplinary frameworks (with regards to information content of different disciplines) in determining workplace solutions for musculoskeletal disability. This is an important step to assure clarity of the strategies implemented in the workplace so that the RTW process is comprehended by all stakeholders. Empirical studies similar to this one may help identify data overlap between rehabilitation professionals and better define the different conceptual models applied in practice.

In addition, the work variables pertinent to disability management have not yet been investigated directly from an ergonomics perspective. The terminology employed by different research studies can be misleading because they lack unified definitions of the work factors and/or explanation of the context in which these factors have been investigated (Durand et al., 2007). This has become a major challenge in this field. Our findings attempt to address this challenge by defining concepts important to both ergonomics and rehabilitation. Specific work factors pertinent to occupational rehabilitation practices were identified and defined by ergonomists, which makes the information presented more accessible to practitioners (Appendix B). The definitions of work variables can serve as a basis for further investigations on this topic and may represent an initial step in the direction of building a common language for ergonomics in rehabilitation/RTW of musculoskeletal disability.

5.5.2 Considerations of the model

The WCM has not yet been developed or adapted specifically for rehabilitation/RTW purposes. It was expected that some of its elements would not correspond to the ergonomics evaluation content. Given the lack of ergonomic practice model specific to rehabilitation/RTW of LBD and the complexity of the disability problem, it was necessary to use a theoretical model that offers a comprehensive perspective of the work system as the one provided by the WCM. The top diagram in Figure 5-2 is an open-loop representation of such comprehensive model, which provides details on

the relationships between all elements of this system. A closed-loop description of this model has also been proposed by the authors of the WCM (Genaidy et al., 2002). They subsequently developed the Work Compatibility Improvement Framework (WCIF) which provides more specific information on outcome measures and their relationship with work factors (Genaidy et al., 2007a). Although the WCM methodology is still in its initial stage of validation, the integrated perspective of human-at-work system offered by the WCM (also referred to as WCIF) might be helpful for future studies that explore work-related obstacles to RTW, predictors and risk factors within the scope of occupational rehabilitation. The preliminary comparison of the WCM elements with factors targeted by ergonomists provides an illustration of a work system view from practice-to-theory which has not been explored before. This system perspective of rehabilitation ergonomics might differ from a person-environment view that other rehabilitation professionals may adopt in their practice (Law et al., 1996). To work together as a team, the members should be aware of the different professional perspectives in rehabilitation. (Eve, 2004). More empirical studies with that focus are necessary and in particular, studies aiming to define the conceptual practice models applied in rehabilitation ergonomics.

Considering the interactions between factors present in the work system, the WCM can serve to illustrate how work factors can be classified and how they are interrelated. Relationships among work variables are difficult to explain because they can change over time and are case-sensitive. It is beyond the scope of this study to explain these relations; future ergonomics studies should empirically test the framework presented, perhaps by evaluating which are the "energizers" and "demands" for optimization of performance in a RTW context for individuals with back disability. Only then can the interactions between factors be fully captured and explained.

5.5.3 Methodological considerations

This exploratory and descriptive investigation provides valuable information, and the rigor of our applied methodology should be emphasized. The step-by-step process of the content analysis demonstrates that careful attention was paid to in-depth

methodology planning. The explicit formulation of our research rationale is also of note. According to Rice and Ezzy (1999), interpretive rigor requires the researcher to demonstrate clearly how they interpret the data and to illustrate the findings with quotations from the raw data (Rice & Ezzy, 1999). The data analysis process we employed clearly ensured that data interpretation remained directly linked to the words of the participants as shown in Appendix 2. Semantic validity and reliability of the framework presented were also assured. According to Krippendorff (2004), semantic validity represents the degree to which the analytical categories of texts correspond to the meaning these texts have for a particular reader or the roles they play within a chosen context. The model chosen offered a sufficient description of its elements to assure this type of validity. Inter-rater reliability was also assured before presenting the convergence of ergonomists' consensus on work factors with the WCM elements.

Regarding the study participants, a consensus reached by such a heterogeneous group (e.g., some participants had extensive experience with rehabilitation prior to working in ergonomics, while others had previous experience only in primary prevention ergonomics before starting to work in rehabilitation) made our findings richer and closer to practice realities representing the Montreal area in Quebec.

The final methodological consideration pertains to the study conceptualization. The use of an interdisciplinary template covering various aspects of the work environment when conducting the NGT was central to the methodology. The template encouraged the participants to discuss work factors in an interdisciplinary context. For example, the ergonomists who participated in the study identified several work factors where their data collection overlaps the effort by the occupational therapists. In fact, our previous study recommended that the work environment template be used for such a purpose, particularly as it related to the shared information between the ergonomist and the occupational therapist in the team (Costa-Black et al., 2007). In addition, the template offered a language that might be of more accessible to them because it represented empirical information extracted directed from exchanges during interdisciplinary meetings.

5.6 Conclusions

Ergonomists working in rehabilitation are faced with a complex challenge of evaluating a wide range of work-related variables that often interplay with each other while changing over time and impacting work disability. Best practices in this particular application of ergonomics are yet to be established. As a starting point to better understand the content and process of an ergonomic evaluation for LBD within evidence-based rehabilitation practices, the findings of this study are useful not only to ergonomists, but to all rehabilitation professionals and other stakeholders involved in the disability problem. The results could facilitate a open dialogue about ergonomic practices and help developing successful professional collaboration in work rehabilitation. Ergonomists working in this field could particularly benefit from comparing the framework presented with the one they are currently utilizing, thus giving them a professional point of reference for quality assurance. Moreover, researchers might benefit from using, modifying or comparing our results in future studies of ergonomic practices in rehabilitation.

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CHAPTER 6: STUDY III- THE APPLICABILITY OF ERGONOMICS TOOLS FOR THE REHABILITATION OF LOW BACK DISABILITY: ANALYSIS OF THEIR UTILITY AND CONTENT

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6.1 Abstract

Introduction: The ergonomic evaluation for rehabilitation of workers with musculoskeletal disability is a difficult endeavor. Workplace features must be understood in relation to the disability phenomenon, which is complex in itself as it evolves from a combination of interacting factors within and surrounding the human-at-work system. The multi-professional integration of data required by contemporary rehabilitation/return-to-work (RTW) programs poses also a challenge to the evaluation process. Research in this field is still developing and many questions remain unanswered. It is unknown if existing ergonomic methods are useful in this context or if new ones are needed. This study sought to evaluate the applicability of ergonomic methods for the rehabilitation/RTW of workers afflicted with with low back disability. **Method:** First, a review of the literature was carried out to retrieve methods potentially relevant to rehabilitation/RTW. Second, ten expert ergonomists working in rehabilitation programs in Quebec were consulted regarding their acquaintance with various methods and how they select them. Third, a representative sample of methods was analyzed with respect to their utility and content. **Results:** The opinions of the ergonomists were presented along with an analysis grid of the utility and content of twenty-three tools. **Conclusions:** This study's findings can better inform ergonomists as to the applicability of current methods in rehabilitation/RTW, and may help improve their evaluation strategy and tool selection process. More studies are needed to guide ergonomists in selecting methods to optimize the evaluation process and, consequently to promote best practices in work rehabilitation for those with disabling back pain.

6.2 Introduction

6.2.1 Background

Despite an increasing number of initiatives emanating from different stakeholders, work disability associated with back pain (i.e. low back disability (LBD)) remains a pressing social and economic concern in industrialized countries. One promising trend to address this challenge is the establishment of proactive work-centered rehabilitation programs, which not only provide clinical and occupational

interventions but also promote concerted action among various stakeholders (Durand et al., 2007; Briand et al., 2008; Tompa et al., 2008). Many of these programs have adopted evidence based practice to increase their accountability and cost effectiveness. Two main approaches have been promoted by these programs: 1) the recognition that 'work' plays a role above and beyond establishing an individual's functional limitations (Jette & Bradley, 2000); and 2) the need to target relevant dimensions of work participation, including the various interactions between the person and the environment (Infante-Rivard & Lortie, 1996; Kuijer et al., 2006b; 2006c). Following these evidence-based specifications and in response to practical necessity, there has been a growing demand for professionals with expertise in ergonomics to address the needs of contemporary rehabilitation programs (aka return-to-work/RTW programs), as well as for more ergonomic research on disability management (Amell & Kumar, 2001; Franche et al., 2005a; 2005b; Adams et al., 2006).

As a scientific discipline and a field of practice focused on the evaluation of work to enhance human performance, ergonomics has much to offer to disability management – particularly when one considers the ergonomic principles related to system performance, i.e. health, safety and well-being of both workers and organizations (Dempsey et al., 2000; Armstrong et al., 2001; Snook, 2005). Some effort has been directed at clarifying the components that should be used in disability management and to determining ergonomic methodology appropriate to this field (Abdel-Moty et al., 1988; Amell & Kumar, 2001; Anema et al., 2003; Isernhagen, 2006a). A group of research experts provided valuable recommendations on training, standards, methods, and goals for the 'rehabilitation ergonomist' (Kumar, 1996b; Isernhagen, 2006b). An entire textbook has been written on different methods and interfaces for practical application of rehabilitation ergonomics (Rice, 1998), and several book chapters in the ergonomics literature cover post-injury management using a combination of medical rehabilitation and ergonomic frameworks (Abdel-Moty, 1991; Khalil, 1993; Mital, 1995; Kumar, 1996b; Khalil et al., 1999; Nowak, 1999), have been proposed and applied in disability management to guide in the matching of individual functional capacities with job requirements (Halpern, 1994; Isernhagen, 2006a).

Much of the research related to ergonomic work evaluations has focused on functional limitation; the environmental barriers and facilitators (mainly of social-organizational nature) associated with work participation have been left out (Hadler, 1997; Khalil et al., 1999; Jette & Bradley, 2000; Jones & Kumar, 2001). Furthermore, there has been no consensus on ergonomic work factors of physical nature that have an impact on back disability (Guzman et al., 2007a).

Recently, scientific discussions have evolved around the need for adopting a transdisciplinary and systems-oriented view of the disability problem. For instance, many authors have raised questions on the way rehabilitation services incorporate such a comprehensive approach in practice or the use in practice of a disability framework such as the WHO's International Classification of Functioning (ICF 2001) (Frank et al., 1998; Durand & Loisel 2001b; Briand et al., 2007, Guzman et al., 2007a). Several contemporary rehabilitation programs have described a shift from offering clinical-based interventions to offering work-centered interventions (Imrie, 1997; Innes & Straker, 2002a; Frings-Dresen & Sluiter, 2003; Ijzelenberg et al., 2007). Research in this area is still developing and the application of ergonomics methods and tools is one issue that needs more attention (Durand et al., 2007). Questions on this subject have only begun to be raised. For instance, it is difficult to know from the available literature what are the types of methodologies ergonomists currently utilize in order to address the needs of contemporary rehabilitation/RTW programs. More precisely, which ergonomic evaluation methods do they use within contemporary rehabilitation/RTW programs? What is the content of these evaluations? And, is the content of these evaluation methods conceptually pertinent to these programs?

These questions have no simple answers; however, by beginning to explore the tools and methods used by ergonomists working in rehabilitation/RTW programs might be one step towards the identification of these context specific challenges. This information could potentially help ergonomists move closer to adoption of evidence-based practices; open dialogue with different rehabilitation professionals; and raise questions pertinent to this field of practice. Finally, identification of the tools ergonomists use in this field of practice, as well as the considerations for selecting them, may help target elements that need improvement.

6.2.2 Overview of the literature

The content of ergonomics evaluation

The study of work factors that impact individual's health and/or work participation has been a concern of many disciplines. The classical ergonomics literature suggests that a work system evaluation independent of its purpose must be comprehensive in nature in order to evaluate system's functionalities (Wilson & Corlett, 1995; Westgaard & Winkel, 1997; Shoaf et al., 2000). Recently, Tuncel et al. (2008) critically reviewed the literature on workplace interventions that reduce lower back disorders. The key message from their study was the need for practitioners to assess both physical and nonphysical work environments in order to guide interventions based on workplace-specific needs. In occupational rehabilitation literature, several research studies address similar issues and they too emphasize the necessity of adopting a comprehensive approach to study person-environment in order to prevent and manage chronic (disabling) back pain (Truchon, 2001; Wang et al., 2006; Guzman et al., 2007a).

Although research in this field is still developing, it seems plausible to expect that in practice ergonomists working in rehabilitation/RTW programs are adopting a holistic view of person versus work environment compatibility, or at least one that not only focuses on the physical work exposures (Hochstenback, 2000). A recent study done by the principal investigator and some co-authors of this paper, explored the opinions of ergonomists working in these programs and confirmed that they are indeed engaged in evaluating the full spectrum of the work system surrounding a person presenting LBD (Costa-Black et al., 2008a). That study also shows that ergonomists acknowledge using an interdisciplinary exchange of information on work environment factors, as they are not the sole actors involved in gathering data on the work system elements.

Another study – not specific to work disability issues but worth mention herein – presents a conceptual model of ergonomic decision-making (Piegorsch et al., 2006). By exploring the views of ergonomists with engineering and physical therapy backgrounds, the authors showed the variation in the range of risk factors considered by these professionals, from less comprehensive (physical demands) to

more comprehensive (physical, organizational and psychosocial/cultural characteristics). Their findings suggest that the framework currently utilized by them not only depends on the practical situations they encounter but also on their background (Piegorsch et al., 2006).

It is difficult to know, on the basis of the literature, what are the common frameworks utilized by ergonomists practicing in rehabilitation/RTW settings. As highlighted in the two studies that have investigated current ergonomics practices (Piegorsch et al., 2006; Costa-Black et al., 2008a), there are large gaps between research and practice, thus confirming the need for research linking practical realities with practitioner's needs.

Existing ergonomic methods

The proper usage of methods is a central concern in the discipline of ergonomics in general and it represents a major part of the ergonomist's training curriculum (Wilson & Corlett, 1998). Important reviews can be found in the literature on methods and tools and their utility (Brodie & Wells, 1997; Westgaard & Winkel, 1997; Stanton, 2005). Various methods are available to evaluate the workplace, regardless of their specificity to work disability. On the one hand, there is a significant body of literature about different tools that guide ergonomic practice in work design, analyzing specific tasks to improve health, safety and productivity, and data collection on human performance and interactions with artifacts or with the physical and social environment (Stanton, 2005). On the other hand, a vast literature exists on methods to measure functional work capacity, i.e. functional capacity evaluations (FCE), which are more specifically designed for rehabilitation and RTW purposes (Wind et al., 2006; Innes & Straker, 2002a). Although conceptually related to ergonomics, these instruments are not necessarily tools developed specifically for ergonomists. Rather they can be used by any trained professional, whether they are ergonomists or not. Controversies and questions about the usefulness of FCE for disability management can be found in the literature (Kumar, 1996a; Innes & Straker, 1999a; Cole & Grimshaw, 2003; Ferguson et al., 2005).

The available literature fails to provide a specific methodological framework for practice that can guide the evaluation process of individuals afflicted with LBD. Also, very little research is dedicated to the psychometric properties of ergonomic analysis methods specific for use in rehabilitation/RTW programs.

Driven by practical needs, ergonomists working in this field are relying on methods and tools that are available to them. The majority of methods that exist may assist them in identifying work factors and design intervention without specific considerations to the work disability phenomenon. They not only vary in the level of assessment, from simple checklist to complex apparatus, but also in their underlying conceptual models (Wilson & Corlett, 1995; Shoaf et al., 1998). Many tools, for instance, utilize the well-known stress-strain model (Rohmert & Raab, 1995). The application of this concept for successful disability management has been little explored. The utilization of methods that consider maximal accepted load based on population data in rehabilitation is debatable both ethically and conceptually (Dempsey & Mathiassen, 2006; Rosenblum, 2006). A possible alternative strategy is to consider the load thresholds specific for an individual, taking into account behavioral aspects of work participation such as fear avoidance believe, motivation, etc (Feuerstein et al., 2001; Franche et al., 2002; Cole et al., 2006).

Considering the diverse option of tools and their questionable applicability, the choice of one method versus another is challenging. In the classical ergonomic literature, the qualities of ergonomics methods (such as practicality, usefulness and accuracy), are seen as trade-off choices that ergonomists have to make. An oft-cited consideration relates to the tool's mode of administration (i.e. self-report, observation methods or direct measurements (Winkel & Mathiassen, 1994). Similarly, in occupational rehabilitation the qualities of work-related assessments conducted by physiotherapists and occupational therapists have been described as an equilibrium between qualitative attributes (i.e. utility criteria) and quantitative ones (i.e. dependability criteria) (Innes & Straker, 2003). Innes & Straker (2003) highlight the most important quality attributes for different types of workplace assessments used in Australia. The definitions and identification of attributes of

methods presented by these authors have tremendous value to any professional conducting workplace evaluations; however, this information is not specific enough (and perhaps not practical enough) to guide ergonomists in the selection of methods available to them.

Practicality issues in the selection of ergonomic methods in contemporary rehabilitation/RTW programs have hardly been explored. It might be important to consider the minimum use of rehabilitation resources as these programs can be costly to insurance providers and employers due to their comprehensive approach (Halpern, 2003). It is, therefore, important to explore from the users' point of view what the issues are in methods' selection for the purpose of rehabilitation/RTW, and are the existing methods useful from a practical and theoretical point of view?

6.2.3 Study's purpose

This study aims to evaluate the applicability of ergonomic methods to the rehabilitation/RTW of LBD, with special attention to methods recommended for this purpose. Applicability was evaluated with regard to two aspects: the practical utility of tools and the pertinence of the domains they cover. With this in mind, the following research questions were raised:

1. Are these methods useful according to features specified by ergonomists practicing in the field of rehabilitation?
2. What is the content covered by these methods?

6.3 Methods

To answer the research questions a three-step procedure was undertaken: 1) identification of ergonomic methods; 2) consultation with ergonomists working in rehabilitation; and 3) analysis of the utility and content of a selected group of methods.

6.3.1 Identification of ergonomics methods

To identify methods that could be relevant for this study, an extensive literature search was undertaken. Methods or tools had to satisfy the following selection criteria: 1) should assess work environment factors that can impact individual musculoskeletal health and/or work performance; 2) should be available in English and/or French; 3) should be related to ergonomics in principle; and 4) could be employed by any professional ergonomist.

The definition adopted for this study states that ergonomics is the "design and engineering of human machine systems for the purpose of enhancing human performance" (Dempsey et al., 2000). Accordingly, 'enhancing human performance' is the main focus of ergonomists working across different fields of practice (although it might also be central to other disciplines as well, in particular to occupational therapy) (Kielhofner, 2002). The human performance concept is large in scope and for this reason the selection criteria had to be as robust as possible. Another reason for exploring such a diverse group of tools was the lack of a consensus on a set of ergonomics tools for rehabilitation purpose. In summary, the focus of this review was on identification of all existing tools or methods that evaluate work demands made upon people as they are implicit elements of system performance (Wilson & Corlett, 1995).

A method that satisfied the above criteria was excluded if:

- It had been developed exclusively for either laboratory studies or epidemiological studies;
- It mainly assesses risk factors related to body parts other than the lower back;
- It assesses safety hazards (e.g. for fall prevention, slip or any accident-related hazards) or specific environmental stressors (e.g. vibration, noise, chemical exposures, etc);
- It represented an on-going strategy for implementing an ergonomics program; and
- It was a functional capacity evaluation.

Using both manual and electronic searches, articles and reports from January 1983 to January 2006 yielded several methods that met the inclusion criteria. A particular effort was made to identify methods from different databases, covering ergonomics, industrial psychology and rehabilitation medicine, given that these are the main fields of practice involved in the evaluation of work situations for persons with musculoskeletal disabilities. An expert librarian was consulted to verify the search strategies and to evaluate the need of including additional databases through a bibliographic program directory called ULRICH'S. A final electronic search was made of Web of Science, PsychINFO, COMPENDEX and Ergonomics Abstracts. These searches were supplemented with citation tracking, personal database (Reference Manager), the use of the World Wide Web, and communication with experts in the field. The following key words or combinations of these key words were used: job analysis; work demands; work environment; ergonomics assessment; workplace evaluations; ergonomics methods; and performance. Two trained reviewers (both students with a Masters degree in Ergonomics) tracked additional citations by searching for the exact name of the instrument in at least one of the databases listed above. The goal was to gather all documents pertinent to a particular method in order to compile the necessary information to analyze each tool. A review grid was developed by consensus among our research team members to systematically retrieve the available information about each tool. The grid contained items such as authorship; purpose; type; recommended field of application; covered domains; model or theoretical framework used; mode of administration; the occupational setting where applied; level of analysis; procedure for data collection and analysis of results; training required; reliability tests (types and results); validity tests (types and results) and others. This review grid is available to the reader upon request. The same reviewers participated in extracting information on each tool identified.

6.3.2 Expert Panel

Participants were selected based on the following eligibility criteria: 1) ergonomics practitioners with a certified educational training recognized by the Association of Canadian Ergonomists (ACE); 2) practitioners that have worked for at least 1 year at the time of the study in a rehabilitation/RTW program that includes an ergonomic

component; and 3) must have worked as a collaborative member of a rehabilitation team. A database directory called Quebec Rehabilitation Research Network (REPAR) was used to contact professionals with this specific work experience or to obtain referrals to colleagues who work in rehabilitation. Nineteen invitations were sent out electronically to ergonomists in Montreal (Quebec), fourteen responded and ten met the eligibility criteria. Aside from the recruitment effort, it was difficult to find a large number of expert ergonomists working in rehabilitation centers within metropolitan Montreal.

A structured questionnaire survey was developed by the research team with attention to its content and face validity. The survey design and content was piloted in face-to-face interviews with two professional ergonomists with over four years experience in rehabilitation/RTW. This methodology used for developing the questionnaire has been proposed by Oppenheim (1992). The two ergonomists verified the questionnaire structure, each question format, and the coherence of the list of methods that was extracted from the literature review. Methods that they were unfamiliar with were kept in the questionnaire. Later these methods could be analyzed in terms of their applicability in rehabilitation. The ergonomists confirmed having experience with different types of methods included on the list, from comprehensive job analysis to simple checklists. Besides the original list of methods presented to them they suggested including two other methods they had experience with. These were the European ergonomics standards (CEN-EN 1005 series) and the Dictionary of Occupational Titles (DOT).

The most important consideration in the development of the questionnaire format was the clarity and ease of use of the questions so as to avoid missing data. Thus, it included mainly close-ended questions in a checklist format. It was also giving the participants an opportunity to provide additional comments about each of the methods presented to them. They were also asked if they had experienced using any other method not included in the list presented. Participants were instructed to read each question, reflect on their knowledge and experience working in rehabilitation (in particular with LBD cases) and check mark each one accordingly. The questions had the following format: 1) a two-point scale (yes/no) was used to

classify tool usage; and 2) a three-point scale was used to rate the importance of each feature considered in tool selection.

Regarding the latter, the research team agreed on a list of practical features extracted from ergonomic textbooks and from studies related to rehabilitation assessments (Table 6-1). Participants were then asked to rate each feature by its importance for rehabilitation (0 = unimportant, 1 = important and 2 = very important). The 'relative importance' of each feature was determined by comparing each score against the agreement between participants as follows: the feature is 'not important' when more than 50 % agreed on a 0 score; the feature is 'important' when more than 50 % agreed on a score of 1 or when 40% to 50% agreed on a score of 2; and the feature is 'very important' when more than 50 % agreed on a 2 score). Participants were encouraged to add any comments related to the logistics and challenges for methods selection.

Table 6-1: Features for selection of tools (extracted from the literature)

Features for tool selection	
- Adapted to various workplace situation	- Overall satisfaction
- Accounts for the level of injury	- Provides meaningful results for rehabilitation
- Easy data documentation	- Recognized in the field
- Easy data analysis	- Reliable
- Easy to justify insurance reimbursement	- Results are easy to interpret
- Little time required	- Results are easy to report
- Low costs involved	- Rich in details
- Minimum or no training required	- Valid
- No equipment(s) required	- Well-known by key stakeholders

Data was collected from the 10 participants via electronic mail and the questionnaire was attached as a document (Dommeyer & Moriarty, 2000). The advantages/disadvantages and applications of this research method are presented elsewhere (Cobanoglu et al., 2001). This method was chosen because it enabled gathering relevant information rapidly from individuals with limited time available, as in the case of the participants eligible for this study. Secondly, this method allows greater flexibility to respondents (they can choose how and when to

respond). A set of ethical and practical rules developed for conducting internet research was followed (Michalak & Szabo, 1998).

A formal ethical approval was not required at the time of collecting data. The confidentiality of all information obtained was guaranteed via a formal letter to the participants, adhering to the rules of internet research and the recommendations of the Interagency Advisory Panel on Research Ethics (Government of Canada). It was made clear to the participants beforehand that their participation was voluntary and that they may refuse to answer any question at anytime.

Completed survey responses were gathered in June 2006 and analyzed thereafter (responses were received over a period of 2 weeks). The responses from close-ended questions were analyzed as quantitative-informed data according to content analysis rules, i.e. each response was manually counted along lines of frequencies among all the participants (Mayring, 2000). For the open-ended questions, textual data were explored inductively for content analysis. The rules and steps for text analysis and interpretation for this inductive process were followed according to suggestions made by Landry (1997). This involved counting and comparing keywords or content, followed by the interpretation of the underlying context (Landry, 1997).

6.3.3 Analysis of ergonomic methods

A pre-analysis phase took place to identify a pertinent group of methods from the list generated from the literature review process. Firstly, all tools that had been recommended for use in rehabilitation/RTW were retrieved for analysis of their content and utility. This information was based on the reference sources pertaining to each tool (i.e. peer-reviewed articles and book chapters). Secondly, the methods used by the participants were analyzed regardless whether they had been recommended for rehabilitation/RTW. The main rational for including this group was that this study intended to capture the reality of current practices instead of relying solely on information obtained from the literature.

Once the most pertinent group of ergonomic methods was identified, the analysis of their applicability (with regards to the utility features and content of tools) was undertaken. According to the American Heritage Dictionary (2003), utility means "the quality of being of practical use". In measurement research, utility often refers to the usefulness of the assessment results (Innes & Straker, 2002a). There are different types of utility: utility of a measure to the organization, to an individual, and the utility of the instrument itself (Shoaf et al., 1998). In this study, the focus is on the usefulness for the evaluator or the user of the information. As such, the utility of methods was analyzed with regards to the most important feature of tool selection as considered by a group of ergonomists working in rehabilitation programs.

For the analysis of the contents of ergonomics tools, the main objective was to create a platform that allows a simple comparison between current methods. A secondary objective was to identify the comprehensiveness of each tool. Shoaf et al. (1998) presented the elements of an inclusive work system model that offers a platform for such an assessment. According to this model, work system analysis should capture and consider the individual and interactive effects of variables related to hazards and risks at the workplace (Shoaf et al., 1998; 2000). Each element of this model is summarized in Table 6-2.

Table 6-2: Description of the elements of an inclusive work system model (adapted from Shoaf et al., 1998).

Element	***Description***
Environmental elements	Conditions such as heat, cold, lighting, noise, etc.
Physical workload	Static or dynamic stress such as manual materials handling, sitting, postural considerations, etc.
Mental workload	Cognitive-sensory processing such as reading or listening; information processing, etc.
Social elements	Relationships and communication with peers, supervisor, customers, etc.
Organizational elements	Company structure, reward system, morale, work goals, autonomy, significance, etc.
Human-task interactions	Individual interactions with activities such as setting up equipment, arranging objects, etc., all of which affect task performance.
Individual capacities	Personal characteristics, including anthropometric data, individual's perceived emotional, cognitive, physical abilities including ability to cope with stress, motivation, etc.

Both the utility features and the content were rated on a three-point scale (0= not at all; + = somewhat; ++ = very) by one rater (the principal investigator) who had read all the literature on each tool. Two co-authors (D.I. and M.H.) verified the ratings for the tools with which they have had previous experience. In the case of a score disagreement, discussions followed until final agreement was reached. The three-point scale represents the main scoring system for the analysis of the utility and content; however, to standardize the rating system each score needed to be specified further. Once the participants identified the features of each tool, these were then rated according to the scales listed in Appendix C. The rating scores for five of the features were elaborated partly on the basis of the experiences of some members of our research team with ergonomics methods and partly on the research team's common knowledge on work disability research (in particular the feature 'meaningful data'). The rating of 'meaningful data' is the only one specific to rehabilitation/RTW. The other features are not specific to rehabilitation; nevertheless, they represent key aspects of this practice according to the majority of participants. Validity and reliability were rated in terms of the number of studies found that reported positive results (Appendix C). For the analysis of content, each qualitative descriptor was specified as follows: 'not at all' - i.e. the tool does not cover this concept; 'somewhat' - the tool covers at least one aspect of this concept; and 'very' -the tool covers many aspects of this concept.

6.4 Results

6.4.1 Identification of ergonomic methods

From the instruments identified through the literature review, sixty-five methods met both inclusion and exclusion criteria. Twenty-six methods were excluded on the basis of the five criteria described above. Only five fell outside the inclusion criteria. One tool in particular, the Work Environment Impact Scale (WEIS), met all inclusion criteria except for the fact that it was developed for occupational therapists only (Kielhofner, 2002). Interestingly the WEIS is one of the few tools identified that assesses work environment factors impeding work participation based on a disability model (Kielhofner, 2002). According to Kielhofner (2002), the factors included in the WEIS may impact the worker's performance, satisfaction, and physical, social,

and emotional well-being, all of which are common parameters utilized in ergonomics theories and work system models (Wilson & Corlett, 1995). As we purposely tried to be as inclusive as possible in the selection criteria, it was expected that methods would overlap. It is important to mention that the methods selected had to be for use by ergonomists but not exclusively. Thus, some tools identified could also be used by occupational safety and health personnel, industrial hygiene professionals, psychologists, engineers, occupational therapists, etc.

From the list of sixty-five methods selected, only two specifically take into account the work disability status of individuals (i.e. the enabling or disabling work-related factors). They are the Organizational Policies and Practices (OPP) questionnaire (Amick III et al., 2000) and the Work Role Functioning Questionnaire (WRFQ) (Durand et al., 2004). Two other tools consider risk factors that might be associated with disability outcomes: the Job Description Questionnaire (JDQ) – aka Risk Factors Questionnaire/RFQ – includes work-related factors possibly associated with delayed recovery (Halpern et al., 2001); and the Lifting Guidelines assesses the RTW readiness of patients with low back disorders (Fergusson et al., 2005).

Information was extracted on each tool to help classify them into two main groups: tools that have been recommended for rehabilitation/RTW, and the ones which have not. From sixty-five tools, only eighteen tools have been recommended for this purpose. The tools which have not been specifically recommended for rehabilitation/RTW according to the literature, consisted of: workload assessments (e.g. Overall Workload Level, Cooper-Harper Scale, NASA Task load index, Subjective Workload Assessment Technique, etc.); quantification methods of the physical load imposed on the back (e.g. ACGIG TLV for the back, Utah back compressive worksheet, Biomechanic Lifting Equivalent, etc.); guidelines and standards to reduce risk factors (e.g. European and American Standards – CEN and OSHA), job analysis techniques (e.g. Common-Metric Questionnaire, Quantitative Workload Inventory, etc); and various risk assessment checklists (e.g. Manual Task Risk Assessment Tool (ManTRA checklist), Direct Nurse Observation Instrument, PLIBEL, etc). The majority of them were methods that identify or quantify work-related risk factors of musculoskeletal disorders based on normative population data. Although the utility of these tools in rehabilitation/RTW is unknown, the lack of

studies supporting their use in this field makes it impossible to analyze the applicability of this particular group by the terms investigated here.

6.4.2 Responses from the ergonomists

The opinions and knowledge of 10 expert ergonomists (3 males and 7 females) from Quebec were collected and summarized. All participants had either a master's degree or a professional specialization degree in ergonomics (known in French as 'diplôme d'études supérieurs spécilisées' – DESS). The majority (n = 9 respondents) had dual professional background: kinesiology (n = 3); physiotherapy (n = 2); occupational therapy (n = 2); physical health education (n = 1); and environmental health & biology (n = 1). They all have been conducting ergonomics evaluations for a minimum of 2 years (mean = 7.7; SD = 5.9) and they were working for rehabilitation programs (RTW programs) for a minimum of 1 year (mean = 3.8; SD = 3.5) at the time of this study.

A list of sixty-seven methods was presented to the participants. This number corresponds to the total of 65 tools identified through the literature review process and two other methods that were identified through the pilot interviews (i.e. the European standard for machinery use (CEN-EN1005 series) and the DOT, which were not retrieved during our electronic database search, possibly due to the fact that they are not referred in the literature as a workplace assessment). Twenty-two of them had been used by at least one participant; of those only three tools had been used by more than five participants. They were: Borg Rated Perceived Exertion/RPE (n=8), NIOSH lifting equation (n= 5), and 3D Static Strength Prediction Program/SSPP from University of Michigan (n=5). Nine tools had very low usage (used by less than 20% of participants).

With regards to the key considerations for method selection, more than 50% of participants considered the following features very important in their field of practice: 1) if the tool is 'adapted to various workplace situations'; 2) if it is easy to use with regards to 'data collection & analysis'; 3) if data gathered 'provides meaningful results' in relation to rehabilitation/RTW process or disability status; 4) if they like the tool ('overall satisfaction'); 5) if the tool is 'valid'; and 6) if it is

'reliable'. All these features, except for 'overall satisfaction', were the ones used for the analysis of the utility of tools in rehabilitation/RTW, presented in the next session.

From the comments made by the ergonomists on tool usage and method selection, four participants revealed that they have been using the entire tool or "sometimes" only parts of it because the "whole tool might not be necessary". They also mentioned that a different set of methods might be used in each case, depending on the need; in some cases, no method is used at all. One participant stated that "sometimes we have to rely on what we see and ask without the use of any tool". When they were asked if they have used any other tool which was not included on the questionnaire, three of them reported using their "own systematic way to assess the workplace situation" or their "own checklist" developed based on their years of experience evaluating different workplaces sites and situations.

A few aspects of methods selection were revealed. First, ergonomists tend to restrict themselves to 2 or 3 of their favorite methods despite variations in the workplace problems that need to be addressed. Second, the resources available for data collection are likely to influence their selection of tools. Lastly, practitioners are compelled to choose methods that are easier to justify to insurance companies in terms of time required and costs involved.

6.4.3 Analysis of the utility and content of the methods

A set of twenty-three tools was analyzed in terms of their utility and content (Table 6-3 and 6-4 respectively). This number represents all tools that have been recommended in the literature for rehabilitation/RTW purpose and the ones that had been used by at least three of the participants. The choice of a 30% agreement of tool's usage was made mainly on the basis of the representativeness of this group (Miles & Huberman, 1994). Figure 6-1 shows schematically the selection of methods based on the results obtained from the previous two procedures, i.e. identification of methods (Step 1) and consultation with ergonomists (Step 2).

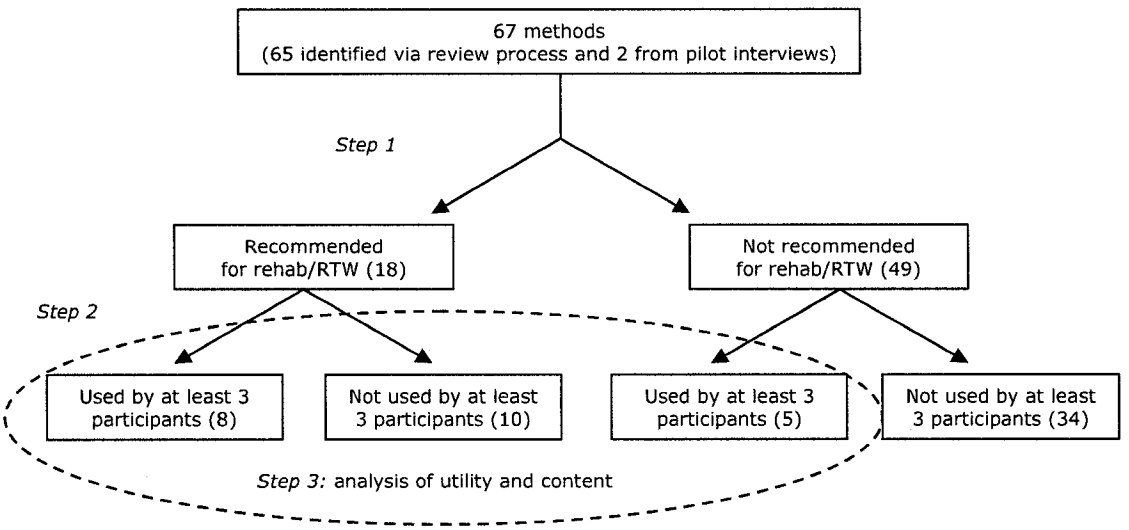

Figure 6-1: Schematic representation of the study design in relation to the decisions of the methods analyzed.

Utility features

Table 6-3 shows the analysis of five utility features of twenty-three ergonomic methods ('adapted to various workplace'; 'easy data collection & analysis', meaningful results', 'realiable' and 'valid'). The main information about each ergonomic method analyzed is also presented. Seven methods are specific for assessing the risks related to low back disorders (the Biomechanical model of lifting, the JDQ, the Lifting guidelines for lower back disorders, the LMM, the NIOSH lifting equation, Snook's tables and the 3D SSPP) (Winkel & Mathiassen, 1994; Ziebarth & Noble, 1998; Waters & Putz-Anderson, 1999). All of these tools have been recommended for use in rehabilitation/RTW. Within this group, the JDQ is the most useful to rehabilitation/RTW with regards to its features; however this tool has been not used by any of the participants. An important feature of this tool is the 'meaningful results' it can provide to rehabilitation/RTW. As previously mentioned, the JDQ examines risk factors that are possibly related to delayed recovery (Halpern et al., 2001). Another positive feature is its easy format which facilitates data collection and analysis. Other tools in this group are 'somewhat useful' according to

the same criterion, i.e. the Lifting Guidelines, the LMM, the Snook's tables (its updated version, Liberty Mutual tables) and the 3D SSPP. The results of the analysis of the Lifting Guidelines for people with Low Back Disorders are based on one manuscript presented by its author (Fergusson et al., 2005). This tool is very specific for lifting tasks and it gives 'somewhat' useful results to rehabilitation/RTW as it considers the evidence on lower back loads that can lead to reinjury. The latter also applies to Snook's tables, except that these tables can be applied for other manual handling tasks besides lifting.

The methods less useful according to the cores of 'meaningful results' feature are the Biomechanical model and the NIOSH lifting equation (i.e. score 'not at all" useful). Although it has been suggested to use these two tools in rehabilitation (Waters & Putz-Anderson, 1999; Chengalur et al., 2004; Adams et al, 2006), practitioners should interpret their results with caution since their output is related only to the reduction of risk of injury rather than to disability and chronicity. In fact, one study was found on the application of NIOSH lifting equation in rehabilitation/RTW to chronic back pain patients; it cautions against the use of this method for setting safe lifting limits in this population (Dempsey, 2002; Kuijer et al., 2006a).

The most complex tool in terms of data collection and analysis was the LMM (Ziebarth & Noble, 1998). However this tool presents positive scores on all other features, especially the validity of its risk model. In practice, when there is a need for more in-depth analysis of the back load, ergonomists might want to consider a more sophisticate instrumentation for measuring 'risk level', especially one that considers three-dimensional trunk motion in its data analysis such as this one.

Table 6-3: Analysis of the utility features of methods

Main information			***Utility parameters***				
Methods	Type/format	Recommended for rehab/RTW	Adapted to various workplace	Easy data collect. & analysis	Meaning ful data	Reliable	*Valid*
AET job analysis method	Job analysis/ rating scale	Yes	++	+	+	++	++
Australian Manual Handling checklist	Checklist	No	+	++	0	0	*0*
Biomechanical model of lifting tasks	Mathematical equation	Yes	0	+	0	0	+
Borg Rated Perceived Exertion (RPE)	Rating scale	Yes	++	++	+	++	++
Dictionary of Occupational Titles (DOT)	Database system	Yes	++	n/a	0	+	+
Fleishman Job Analysis Survey (F-JAS)	Job analysis/ rating scale	Yes	++	+	+	++	++
Job Content Questionnaire (JCQ)	Self-report Questionnaire	Yes	++	+	+	++	++
Job Demands Analysis (JDA)	unknown	Yes	++	n/f	n/f	0	*0*
Job Description Questionnaire (JDQ)[λ]	Self-report Questionnaire	Yes	+	++	+	++	+
Lifting Guidelines for people with LB Disorders	Reference Guideline	yes	0	+	++	0	+
Lumbar Motion Monitor (LMM)	Trunk motion apparatus	Yes	+	0	+	+	+
NIOSH lifting equation	Mathematical equations/ checklist	Yes	0	++	0	++	++
Organizational Policies and Practices (OPP)	Self-report questionnaire	Yes	++	+	++	++	++
OSHA Video Display Terminal (VDT) checklist	Checklist	No	0	++	0	0	*0*
OVAKO Working posture Analyzing System (OWAS/winOWAS)	Video-computer system/checkli st	Yes	++	+	+	++	+
Position Analysis Questionnaire (PAQ)	Interview questionnaire	Yes	++	0	+	++	++
Quick Exposure Check system (QEC)	Checklist	No	+	++	0	+	+
Rapid Entire Body Assessment (REBA)	Rating scale	No	+	++	0	+	+
Rodgers Muscle Fatigue Assessment (MFA)[◊]	Mathematical equation/ Worksheet	Yes	+	+	+	0	+
Snook's tables[β]	Guideline	Yes	+	+	+	++	++
Washington State Checklist	Checklist	No	+	++	+	0	*0*
Work Role Functioning Questionnaire (WRFQ)	Self-report Questionnaire	Yes	++	+	++	++	++
3D (2D) Static Strength Prediction Program (3D SSPP)	*Software*	*Yes*	+	+	+	*0*	+

Notes: In gray: Tools used by at least 3 participants; n/a non applicable; n/f not found information; [λ] aka Risk Factors Questionnaire (RFQ); [◊] aka Rodgers and Bernard's method; [β] aka Liberty Mutual tables (updated version of Snook's tables); *Main rating:* 0 = not at all; + = somewhat; ++ = very.

Three methods on Table 6-3 have not been recommended for rehabilitation/RTW: the Australian Manual Handling checklist; the OSHA VDT checklist; and the Washington State Checklist. They have been used by at least 3 ergonomists from our study. One possible explanation for their popularity is their easy format and access, given that all three of them are checklists with easy public access (available via the World Wide Web). The problem with these tools is that they showed low scores (i.e. scores 'not at all') in their psychometric properties. In research, the use of valid and reliable tools has been largely encouraged (Stanton, 2005). However, practitioners (at least in the case of our study group) ignore or are unaware of these properties (they have been using methods with no studies on their validity and reliability). In fact, some participants mentioned that they use their own developed method. This is testament to the critical gap between research and practice.

Two other tools, which have been recommended for rehabilitation/RTW, had low score on validity and reliability (Rayboult et al., 2002; Rodgers, 2005). They are: the JDA and the MFA. The JDA is a method based on prediction of work tolerance and it has been largely applied and modified by rehabilitation services as a template for Functional Capacity Evaluations[1]. Nevertheless, its content and features are not available to the public and no tests of its psychometric properties could be found in the scientific literature. The analysis presented here is based on the only available reference on this method (Jones & Kumar, 2003). With regard to the MFA, one study reported positive results on its validity; no studies were found on its reliability. Its predictive model of fatigue (based on Rohmert's work/recovery time curves) has been largely validated in the automobile industry (Rodgers, 2005). Although more studies are necessary to draw more specific recommendations about the usefulness of this tool in a rehabilitation/RTW context, it is important to mention that it has been widely used for job design in industry to control accumulating fatigue in different body parts and thus minimize the risk of reinjury.

1- Information retained from the World Wide Web using Job Demands Analysis as keyword.

In summary, the tools showing positive scores on all five utility features are the following: the AET, Borg RPE, the F-JAS, the JCQ, the JDQ, the OPP questionnaire, the OWAS, Snook's tables, and the WRFQ. The OPP and the WRFQ in particular are 'very' useful according to the information they provide for rehabilitation/RTW (i.e. utility feature 'meaningful data'). Only three of these tools have been used by at least 3 participants of our study (i.e. Borg RPE, JCQ and Snook's tables). This illustrates the lack of utilization of the tools that meet the quality criteria established in this study.

Content

The analysis of the content (table 6-4) was mainly aimed at generating a platform that allows a comparison between the methods and to identify the overall level of comprehensiveness of each tool. Based on these objectives, a few observations from the findings should be highlighted.

First, none of the twenty-three tools covered all seven components of the work system. As expected the domain most covered by this set of tools is the 'physical workload'. The tools that do not include this domain are: the Borg RPE (which covers individual's perception of any type of exertion) and the OPP (which covers individual's perceptions of mainly organizational and some social elements). The domain which is least addressed by these twenty-three tools is 'social elements' (only six tools cover some of its concepts), followed by 'mental workload' (seven tools).

The most comprehensive tools that have been used by participants were the Australian MH checklist and the JCQ. All other tools used by them covered one to three work system elements (mainly 'physical workload' and 'human-task interactions'). These tools are referred to as micro-assessments (Shoaf et al., 1998) and some of them might offer a certain degree of detail (i.e. for a more in-depth analysis) of a particular work factor. For instance, the Biomechanical model for lifting tasks, the NIOSH lifting equation, Snook's tables and the 3D SSPP all offer analysis of the physical load over the spine during a specific lifting task. Other micro assessments used by participants are specific screening tools for identifying the

most difficult task or to analyze possible risks among different tasks that need to be evaluated further (e.g. Borg RPE, Washington State checklist, REBA, and QEC).

The tools that have a comprehensive scope but were not used by the ergonomists were: The AET, the F-JAS, the JDQ, and the WRFQ. Only one tool used by them covers the domain 'social elements' (i.e. the JCQ).

Table 6-4: Analysis of the content of methods

Method/tool	*Covered domains*						
	Environment elements	Physical workload	Mental workload	Social elements	Organizational elements	Individual capacities	Human-task interactions
AET job analysis method	++	++	++	++	++	0	++
Australian Manual Handling checklist	++	++	0	0	++	++	+
Biomechanical model of lifting tasks	0	+	0	0	0	+	*0*
Borg Rated Perceived Exertion (RPE)	0	0	0	0	0	+	*0*
Dictionary of Occupational Titles (DOT)	0	++	++	0	0	0	++
Fleishman Job Analysis Survey (F-JAS)	0	++	++	+	0	++	+
Job Content Questionnaire (JCQ)	0	++	++	++	++	++	+
Job Demands Analysis (JDA)	++	++	0	0	+	0	+
Job Description Questionnaire (JDQ)[λ]	+	++	+	0	+	0	+
Lifting Guidelines for people with LB Disorders	0	+	0	0	0	0	+
Lumbar Motion Monitor (LMM)	0	+	0	0	0	0	*0*
NIOSH lifting equation	0	+	0	0	0	0	*0*
Organizational Policies and Practices (OPP)	0	0	0	+	++	0	*0*
OSHA Video Display Terminal (VDT) checklist	+	+	0	0	0	0	*0*
OVAKO Working posture Analyzing System (OWAS/winOWAS)	0	+	0	0	0	0	+
Position Analysis Questionnaire (PAQ)	+	++	++	++	++	+	*0*
Quick Exposure Check system (QEC)	+	+	0	0	0	0	+
Rapid Entire Body Assessment (REBA)	0	++	0	0	0	+	*0*
Rodgers Muscle Fatigue Assessment (MFA)[◊]	0	+	0	0	0	+	*0*
Snook's tables[β]	0	+	0	0	0	++	*0*
Washington State Checklist	+	++	0	0	0	0	+
Work Role Functioning Questionnaire (WRFQ)	0	++	++	+	++	++	++
3D (2D) Static Strength Prediction Program (3D SSPP)	*0*	+	*0*	*0*	*0*	++	+

Notes: In gray: Tools used by at least 3 participants; [λ] aka Risk Factors Questionnaire (RFQ); [◊] aka Rodgers and Bernard's method; [β] aka Liberty Mutual tables (updated version of Snook's tables);
Main rating: 0 = not at all; + = somewhat; ++ = very.

6.5 Discussion

There is a compelling need for a better understanding of the practical utilization of ergonomics methods employed in contemporary rehabilitation/RTW programs, especially now that there is convincing evidence showing that work should be at the center of disability management strategies (Reynolds et al., 2006; Durand et al., 2007). Research in this field is in its early stage and this study is a preliminary exploration of the applicability of ergonomics tools in rehabilitation/RTW. This project is the third in a sequence of studies aiming at developing a decision-support framework for ergonomic job evaluations relevant to LBD that meet the needs of contemporary rehabilitation/RTW programs. The first project empirically identified the information shared by an interdisciplinary team regarding the work environment domains pertinent to RTW of ten LBD cases (Costa-Black et al., 2007). The second project presents a consensus from a selected group of ergonomists on the work variables underlying the ergonomic evaluation for rehabilitation/RTW of LBD cases (Costa-Black et al., 2008a). The present study explores different aspects of method utilization in rehabilitation/RTW. Although the views surveyed in this paper are representative of one small group of ergonomists, it provides information on what is happening in practice, thus revealing some of the gaps between research and practice. The following subsections discuss the key findings of this study and make recommendations for a future research.

6.5.1 The practical utility of ergonomics methods

This research was an effort to identify useful methods for the ergonomist working in contemporary rehabilitation programs according to a few quality features of tools. Many other features (besides the ones analyzed herein) may be deemed important for determining the usefulness of a method (Innes & Straker, 2002a; 2002b). The main reason for paying attention to these particular features (Table 3) is the fact that they represent the considerations applied by experienced ergonomists to select methods for their practice.

With regards to the psychometric properties of the tools, the analysis of validity has to be interpreted with caution. In most tools analyzed, validity tests specific to the population with LBD or chronic back pain were rare (Amick III et al., 2000; Durand et al., 2004; Ferguson et al., 2005). Thus, our analysis was restricted to any available tests of validity and reliability of each tool. The fact that certain tools are being used in the field regardless of their psychometric properties suggests that there is a gap between the current knowledge and practice. Moreover, our findings revealed that only three out of ten tools that have positive features were used by the participants. In light of these results, it is suggested that the feasibility of method utilization in rehabilitation/RTW should be explored further in order to better understand practitioners' needs. Researchers and tool developers should work in closer collaboration with practitioners to generate more accessible information on tool properties and their pitfalls, which will then serve to guide in proper tool usage.

Moreover, the ergonomic tools recommended for rehabilitation/RTW varied in relation to the 'meaningful results' they provide. It was difficult to comprehend from the description encountered in the literature what is the basis for recommending a particular tool for rehabilitation/RTW purposes. For instance, most studies mentioned the application to rehabilitation without describing the rehabilitation interface or the conceptual model that the tool would be useful for. Often, the reason for recommending a method for rehabilitation/RTW was that it could identify risk of reinjury. Only the OPP, the Lifting Guidelines for Back Disorders and the WRFQ specify the basis for this recommendation. The OPP in particular considers RTW predictors for chronic pain and disability (Amick et al., 2000; Truchon, 2001). Methods that identify various ergonomic problems in the workplace based on epidemiological data on injury occurrence may offer very little in terms of influencing the client's RTW outcomes. In fact, several studies have shown that factors impacting work participation are very different than the ones linked with injury causation (Marras, 2000; Matheson, 2001; Cole & Rivilis, 2004, Kuijer et al., 2006c). Practitioners need to become aware of the difference in the identification of ergonomics problems and proposed solutions between the different stages of musculoskeletal prevention. Only then will the selection of methods for rehabilitation/RTW purposes be less challenging (i.e. practitioners will have specific

options to choose from) and perhaps more standardized across ergonomists with various professional background.

6.5.2 The content of ergonomics methods

In addition to exploring practical utility issues, this study also explored the comprehensiveness of the tools. Ergonomists are expected to take a system perspective to analyze work and the performance of individuals with LBD. It is recognized, however, that in work rehabilitation programs this view of the work system is often obtained through interdisciplinary exchange (Costa-Black et al., 2007). By investigating the content of the formal procedures used by ergonomists in rehabilitation/RTW we can take a further step to understand the practical needs of cross-disciplinary knowledge sharing. For example, only one tool used by the participants covers the social elements (the JCQ) (Karasek et al., 1998). It is possible, however, that another professional in the rehabilitation team handles factors related to the worker's relationships in the workplace.

Furthermore, despite the scientific evidence that organizational factors influence work withdrawal among back pain patients, our results showed that only two tools used by the participants tackle macroergonomics issues (Australian MH checklist and the JCQ). The Australian MH checklist, however, presented low scores on reliability, validity and the pertinence of its data output. On the other hand, the AET, OPP, PAQ and the WRFQ are tools that cover well the organizational domain, present positive utility features, and yet were not used by any of the participants. It is possible that ergonomists identify organizational factors – such as employer receptivity to job accommodations, production demands, enterprise size, etc – without the use of any formal procedure such as the questionnaires cited above.

Finally, it was observed that the tools used most focus on the physical domain. This might be explained by the fact that all the participants had a physical science background (i.e. kinesiology, occupational therapy, etc). Only one study can be found on the influence of disciplinary biases on the scope of ergonomic job evaluations; however, it only presents the difference between ergonomists with physiotherapy and engineering backgrounds (Piegorsh et al., 2006). In the present

study, it is possible that the experience of the participants and their formal educational training may have largely influenced their method selection. Studies exploring differences about the breadth of information covered by ergonomists from various professional backgrounds within rehabilitation/RTW field may help address their practical needs as well as the curriculum necessary for this type of practice.

6.5.3 Applicability of the methods analyzed

The complexities of work systems must be understood and addressed in relation to the disability phenomenon while aiming for methodological accuracy and minimum use of rehabilitation resources. Considering the current evidence in LBD, one must combine the disciplinary expertises needed to achieve this goal. It is difficult to determine the applicability of tools in this context due to the on-going cross-disciplinary data collection and exchange. The present study allows for a few general observations in this regard.

First, very few methods were identified that take into account the RTW process of workers with LBD. Thus, the applicability of several tools in this context can be questioned. Future studies should aim at identifying practical constraints in the use of current methods in rehabilitation/RTW before resources are used for the development of new ones. Information on the quality and psychometric features of tools must reach practitioners so they can become familiar with tools specific to rehabilitation/RTW. For instance, more than fifteen years ago, Fraser (1992) proposed the use of the AET for rehabilitation purpose, because it offers a comprehensive yet flexible job-oriented approach that allows comparisons of constraints and aptitudes (Fraser, 2002). Very little has been done to explore the feasibility of applying this and other comprehensive job analysis techniques in rehabilitation/RTW programs.

Furthermore, any study on ergonomic method utilization should not be separated from a discussion about he intended use of these methods. It is necessary to better understand the components for designing optimal RTW interventions to be able to determine the applicability of ergonomics and others instruments used in rehabilitation. The discussion around the comprehensiveness of tools presented here

was very limited to what ergonomics can offer to these programs (i.e with regards to domains covered by the methods), rather than what these programs need from ergonomics. This limitation is explained by the fact that yet there is no formal consensus on which workplace-based interventions should rehabilitation/RTW programs offer (Briand et al., 2007; Durand et al., 2007). Until a consensus is reached on workplace interventions and on the boundaries of integrating ergonomics within rehabilitation activities, ergonomists will continue to have difficulties in selecting methods that are applicable to this context. For now it is necessary to standardize and formalize the ergonomics evaluation process to facilitate communication among rehabilitation professionals and other stakeholders.

The results of this study also point out to the general lack of methods that can give specific information to ergonomists regarding the work demands impacting work participation of individuals with back pain. Dempsey (2002) calls attention to the fact that ergonomics research has largely focused on healthy subjects and highlights the need to better understand the performance of workers with musculoskeletal disorders and disability. Various tools have been recommended for use in rehabilitation/RTW; however there are not enough studies demonstrating how the information they provide can reduce work demands and promote successful work participation. Studies on current practices and utilization of conceptual practice frameworks are needed to help identify: 1) the specific context in which the ergonomic tools are applied; 2) the degree of complexity of the tools required in rehabilitation; and 3) the utility of the ergonomics data for rehabilitation purpose. Once the evaluation process is clearly described, it will be easier to assess the effectiveness of ergonomic intervention across individuals and work environments.

6.5.4 Study's limitations

Two main limitations of this study should be noted. The first limitation has to do with the method of choice used to explore the opinions of the ergonomists, i.e. a survey questionnaire. One can observe, for instance, that the comments made by participants on their practical experience using ergonomics methods have rich information that could be further explored if a person-to-person interview were applied instead. We were aware of this limitation at the time of piloting the

questionnaire. Originally the questionnaire was designed for this particular format. This option was modified due to time constraints of the eligible participants. The web designed questionnaire accommodated the time availability of these professionals.

Second, the analysis of validity and reliability could not generate the level of details sufficient to determine the usefulness of the methods according to scientifically sound psychometric properties (Innes & Starker, 1999a; 1999b). The focus of our analysis was rather intended to give an overview of the existing validity and reliability studies available for each tool. Further examination with regards to types of validity and reliability tests is necessary. Stanton presents a validation process properly adapted to ergonomic analyses (Stanton, 2005). Its criteria are established against the adequacy of the intervention. This process could be utilized by future studies that evaluate the validity of ergonomic tools for rehabilitation/RTW purpose.

6.6 Conclusions

This study was conducted based on the necessity to better understand the practical usage of ergonomics methods in rehabilitation settings and help orient best practices in this field. The important message from this study is that aside from the applicability of methods, one must consider the skill level and expertise of the ergonomist who makes important decisions regarding the workplace accommodations needed to address LBD. Those ergonomists seeking analytic tools for rehabilitation/RTW may appreciate the information provided herein on the practical utility and content of existing methods. More studies are needed to generate research hypotheses and address the gaps in knowledge about the ergonomic evaluation process in rehabilitation/RTW programs. This project started to answer some questions that have been raised by different stakeholders, particularly regarding the methodology employed in ergonomic practices. Continued efforts must be extended to develop methods for work rehabilitation/RTW for persons with LBD. More studies are also needed to develop a framework for ergonomic practices commensurate with evidence-based rehabilitation programs and interdisciplinary activities.

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CHAPTER 7: CONSOLIDATION OF RESULTS - THE DEVELOPMENT OF THE NEW FRAMEWORK

While it is widely recognized how complex an ergonomic work evaluation can be for return-to-work (RTW) of low back disability cases, the introduction of a scheme to collect and organize data and formalize evaluators' actions may help facilitate this task. This Chapter is dedicated to describing the development of an evaluation framework aimed at helping ergonomists in the decision-making process of work evaluation for individuals presenting back disability. This framework was developed based on the results extracted from the studies I, II and III (chapters 4, 5 and 6 respectively) and the current knowledge in disability management (i.e. a few important theoretical considerations were extracted from the literature review presented in Chapter 2).

7.1 Main foundations for the framework development

To determine the basic components of the framework the most important information from each study (as well as the main scientific facts presented in Chapter 2) were summarized and organized as shown on table 7-1. This data set was used in the elaboration of the framework. This approach is consistent with the application of systems engineering techniques to the development of all kinds of systems or processes (Bahill & Briggs, 2001).

Table 7-1: Dataset used for the elaboration of the framework

Descriptors	Obtained from	Possible actions or decisions to include in the framework	Related to
The evaluation should reflect the work situation of each unique individual	Chapter 2	- Design a structure that can be applied in each individual situation - Consider the application of the framework for evaluation of different types of jobs and workplaces	Evaluation process

Up until now no ideal tool or toolbox exists for rehabilitation/RTW; however, ergonomists should be aware of the features of existing tools	Chapter 6	Present a flexible platform containing the tools analyzed in Chapter 6 to facilitate the selection process (calling attention to their positive and negative features)	Tools available

Table 7-1: Dataset used for the elaboration of the framework (continue and end)

Each descriptor presented on Table 7-1 was classified in relation to which aspect of

The existing knowledge on ergonomic work evaluations is not specific for contemporary rehabilitation/RTW programs	Chapters 2 and 5	Present how the ergonomic work evaluation process can be integrated into the rehabilitation interface	Evaluation process
When identifying the problems present in the work system for a person who is away from work, it is important to consider that it might not be possible to observe the person in his/her working environment	Chapter 5	Obtain information from different sources in order to identify problems present in the work system when the worker cannot be observed in his/her working environment	Evaluation process
The data collection and exchange in rehabilitation is an on-going process	Chapters 2 and 5	Take into account the dynamics of data exchange in a rehabilitation and interdisciplinary team model	Evaluation process
Work-related factors can be positive or negative in the RTW process but efforts should concentrate on identifying problems that can be modified	Chapters 2 and 6	Consider modifiable factors when prioritizing solutions for the problems	Evaluation content
It is important to consider a work system view; however one must be aware of using unnecessary resources in data collection	Chapters 2, 4 and 5	An ergonomic evaluation should be derived from a global work system perspective; later the evaluation should be guided by the determination of RTW priorities decided by the rehabilitation team in order to avoid waste of resources or duplication of data collection with peers (i.e. overlap of data collection)	Evaluation content
There are factors, pertinent to work systems, not necessarily evaluated by the ergonomist that may contribute to a full understanding of the individual situation	Chapters 4 and 5	Pay close attention to the content of information presented by others in the team in order to avoid a reductionistic perspective of the disability problem	Evaluation content
The evaluation should be oriented by a proactive disability management model	Chapter 2	Include actions that can facilitate stakeholders' collaboration and teamwork such as getting stakeholders' input on different levels of information	Evaluation process
It is important to obtain support from workplace actors and comprehend organization management dynamics	Chapter 2 and 5	- Identify actions that can facilitate obtaining support from workplace parties (including union representation) and all people directly engaged with the worker's job;	Evaluation process

the evaluation it references: the process, the content, or the tools (i.e. formal methods). Figure 7-1 shows a broad overview of how each study's findings and the literature review have contributed to designing the steps for the new workplace evaluation of LBD cases. It is important to highlight that each study aimed to adopt a practical orientation of the process, content and/or tools used directly by practioners, either by a group of ergonomists (studies 2 and 3) or an interdisciplinary team working on rehabilitation/RTW programs (study 1).

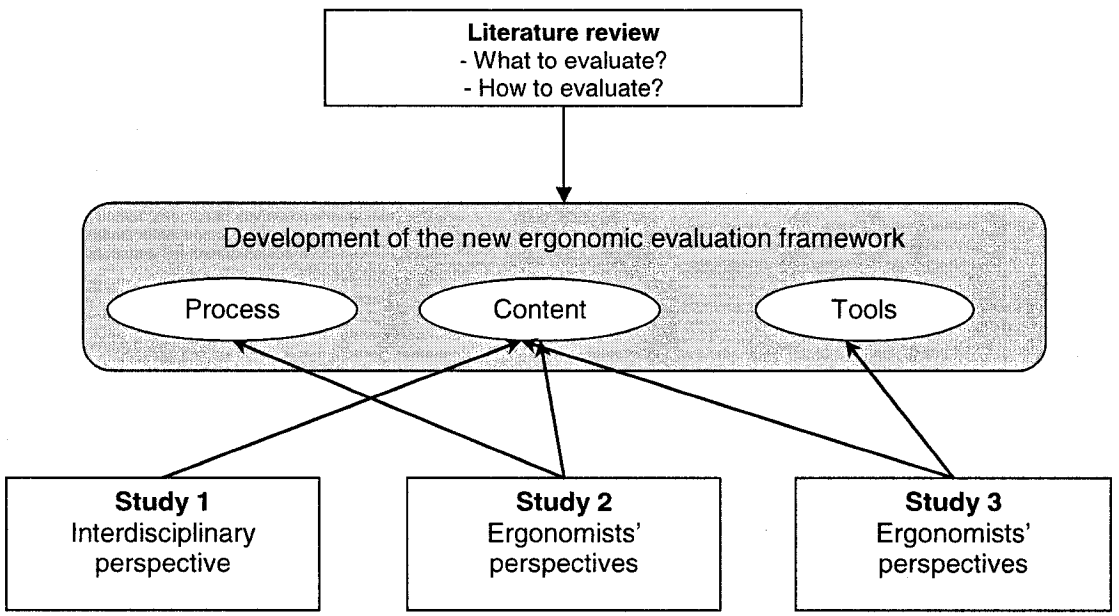

Figure 7-1: Schematic representation the development of the framework

It is also important to specify how the framework was inserted within the rehabilitation team activities. Firstly, it was necessary to take into consideration two separate operations: the plan of action of ergonomists for carrying out any workplace evaluations; and the interdisciplinary plan of action for disability management. As discussed on Chapter 2, the plan of action for a classical ergonomic evaluation consists of the following phases:

- Characterization of problems (i.e. investigation phase);
- Analysis of problems (i.e. interpretation phase); and
- Management of problems (i.e. intervention phase).

These phases were then compared to the interdisciplinary team's plan of action as shown on Figure 7-2. Conceptually, this direct comparison allowed that the ergonomists' steps were developed in synchronization with the actions (i.e. assessment; goal planning and plan execution) proposed by an interdisciplinary team model. In addition to considering the interdisciplinary plan of action, the framework was also designed to promote input from stakeholders since this is an integral part of the overall rehabilitation/RTW process. The input of stakeholders becomes particular important to the ergonomist when workplace design/redesign is part of the RTW solution.

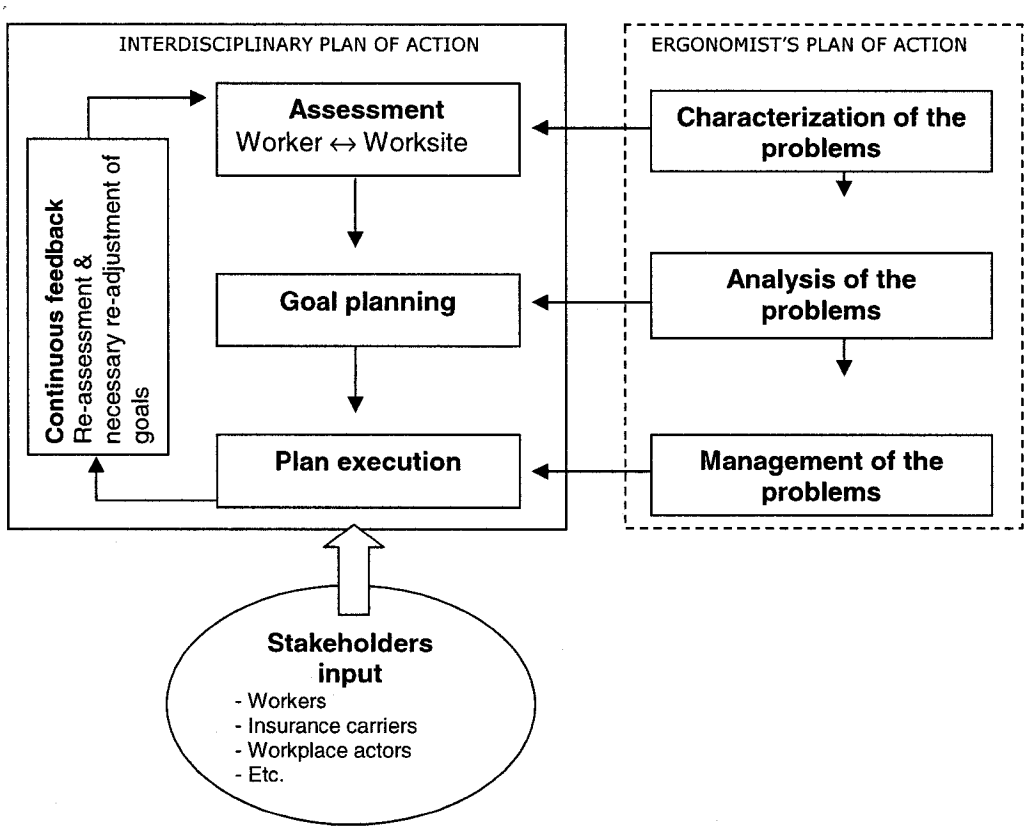

Figure 7-2: Ergonomist's plan of action integrated into the on-going interdisciplinary evaluation process

7.2 The proposed framework

In Figure 7-3 and 7-4 the framework is presented in a flowchart format (i.e. sequence of instructions necessary for designing or documenting a process). While

flowcharts are widely used in various fields and applications, they can be misinterpreted if symbols are not used with uniformity. To avoid such a problem, the flowchart symbols used comply with the requirements of the International Organization for Standardization (ISO) Recommnedation on Flowchart Symbols for Information Processing (ISO 5807:1985).

The flowchart is divided into three main phases: the investigation phase in which workplace problems related to the LBD phenomenon are identified; the interpretation phase in which the problems are analysed; and the intervention phase in which the problems are managed. The details of each phase and the respective steps and decisions the ergonomist needs to take are presented in Figure 7-3 and continued in Figure 7-4. The steps are easy-to-follow and address mainly the question 'how an ergonomic evaluation can be carried out for low back disability cases enrolled in rehabilitation/RTW programs centered in the workplace. The question of 'what should be evaluated' was generally addressed since the framework had to present a flexible structure that could be used in a case-by-case basis. When using the framework, the inventory of work factors presented on Chapter 5 (Figure 5-2) may serve as an initial orientation for ergonomists to become familiar with possible variables to consider when evaluating the workplace for RTW purpose. Further research on those factors is needed in order to make more precise recommendations on the evaluation content. In the future this information should be incorporated into the framework proposed.

The main theoretical and empirical foundation of the framework is presented in Table 7-1 (with references to previous Chapters). The new evaluation framework will be directed at generating decision support, i.e. proving steps for action and decisions in making effective use of existing ergonomic methods and in the inter-functioning of teamwork and collaboration. A decision matrix is part of the framework to orient ergonomists about the positive and negative features of available tools and methods in relation to the phases in which they can be used, i.e. problem indentification phase versus in-depth analysis of the problem (Appendix E).

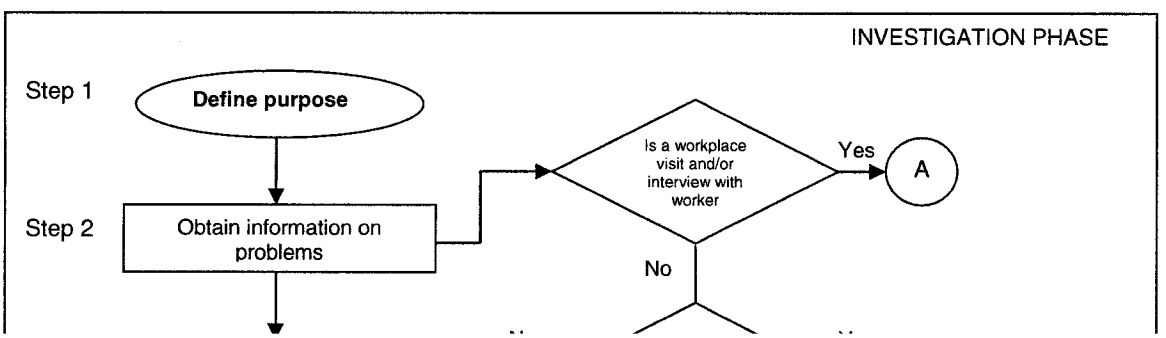

Figure 7-3: Ergonomic evaluation framework for low back disability cases

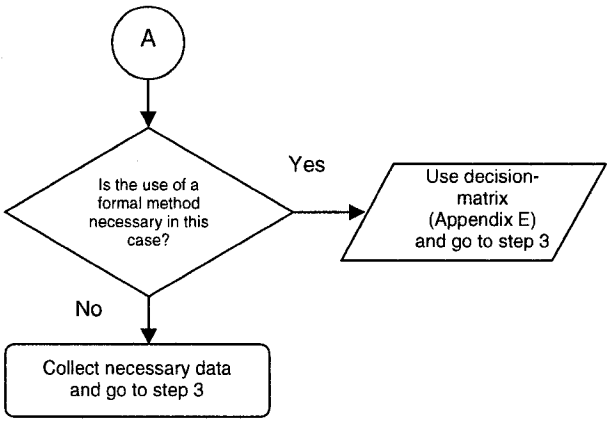

Figure 7-4: Connector A of the ergonomic evaluation framework

7.3 Important considerations

In order to properly use the framework it is important to call attention to a few considerations of its utilization on the content, tools included, users and the population targeted.

7.3.1 Regarding the evaluation content

Firstly, it is important to stress that it is not always job design (or redesign) that is the root cause of disabling back pain, and an unnecessary comprehensive ergonomic evaluation could lead to poor usage of human resources. Ergonomists should prioritize the identification of problems that are specific to the disability problem. Secondly, it is commonly accepted in rehabilitation that data gathering on work environment factors is not the exclusive task of ergonomists. For instance, psychologists often utilize self-reports to obtain information on psychosocial/organization exposures at the workplace, while occupational therapists often evaluate individual performance using practice models which mainly use a patient-centered disability approach. Whenever a teamwork model is used it is necessary to pay close attention to any potential overlap of data that might generate duplication of effort among members of the team and use of unnecessary resources. This was an important consideration in assuring that findings were

shared with others in the team and close collaboration was maintained with workplace actors (i.e. the worker, employer, supervisor, union representative).

7.3.2 Regarding the included tools

A hypothesis developed from this research is that existing ergonomic methods are not ideal for rehabilitation/RTW purpose, mainly because most formal methods do not assess work factors directly associated with RTW outcomes. The framework presents an alternative solution to this problem by guiding the ergonomist's options of existing methods based on the analysis of their features (Chapter 6). A revision of the decision matrix for selection of tools (Appendix E) might be necessary when ergonomic tools specific for rehabilitation/RTW are developed in the future.

7.3.3 Regarding the evaluator (users)

Another consideration in the utilization of the framework is the skills required of the evaluator. Although the format of the framework is very easy to follow, it is important to consider that any professional acting as a RTW facilitator needs to have good communication and negotiation skills in order to obtain the necessary support from workplace actors who might be responsible for making decisions related to the worker's job situation and functions. Moreover, independent of the ergonomists' background (e.g. professionals with rehabilitation science versus engineering background) or training school (e.g. French ergonomics versus human factors approach), he/she should utilize a model system as prescribed for ergonomic practices across different fields. This model system perspective is summarized in a definition of ergonomics proposed by Dempsey (2000), i.e. the design and engineering of human machine systems for the purpose of enhancing human performance, in which the determinants of optimum performance are safety, health, quality, well-being and productivity. This definition of ergonomics pleases the ergonomist who considers the work activity at the center of the evaluation process (French ergonomist) or the ergonomist who considers the human-at-work interactions from a human factors perspective, mainly because it focuses on the concept of work performance.

Moreover, although the framework was developed for the use of ergonomists working within a rehabilitation group, it may also be a useful tool for rehabilitation professionals to develop an improved capacity to assign priorities for ergonomic intervention. This recommendation is justified by the fact that the framework was developed attending to the ergonomists' needs while considering the information sharing and exchange among rehabilitation professionals on work-related factors pertinent to LBD cases.

7.3.4 Regarding the target population

Lastly it is important to highlight that the evaluation framework is geared towards individuals afflicted with low back disability, whom are unable to perform their job functions due to back pain, are thus away from their work for at least 4 weeks (subacute or chronic pain), and are enrolled in a rehabilitation program centered in the workplace. The evaluation framework is a context sensitive-process that considers each individual's situation.

CHAPTER 8: GENERAL DISCUSSION

8.1 Implications and limitations of findings

Contemporary rehabilitation/return-to-work (RTW) programs for management of musculoskeletal disability do not emphasize eradication of the person's symptoms. Instead they focus on the person's disability situation in relation to the many interacting factors that are part of the workplace, compensation, healthcare, and personal systems (Joslyn, 1999; Loisel et al., 2001a). Three key strategies are characteristic of these programs: 1) a focus on reassurance messages such as staying active and early RTW; 2) the use of interventions carried out in the workplace; and 3) an emphasis on the development of partnerships with stakeholders. This dissertation took into account current occupational disability models and operational modes adopted by these programs while simultaneously raising questions on the ergonomics methodology employed. This theoretical direction and approach have led to the identification of important gaps between research and practice.

As a result, this dissertation presents valuable guidance to ergonomists to evaluate individuals with low back disability (LBD) whom are enrolled in these programs. The process, mode and the content of these evaluations were explored empirically in three studies. Each study was geared towards exploring key aspects of workplace evaluations which could generate the knowledge that supports ergonomists actions and decisions commensurate with evidence-based rehabilitation/RTW programs.

In the development of the evaluation framework close attention was paid to: 1) the everyday reality of work rehabilitation programs; 2) the existing knowledge on the ergonomic methodology being applied; and 3) the current evidence on management of musculoskeletal disability. With these issues in focus, the framework proposed in this dissertation serves as a practical, scientifically sound and easy-to-use procedure for conducting ergonomic evaluations. The framework allows ergonomists

to be better equipped to determine workplace solutions for a given disability problem because it considers not only the complexity of LBD, but also facilitates the inter-functional planning and communication among all stakeholders that is central to this issue. In fact, any strategy towards remediation or eradication of this problem must consider stakeholders' involvement. In the case of ergonomic work evaluation for rehabilitation/RTW, appropriate buy-in from workplace actors must be secured from the very beginning. This support will assure that effective and sustainable workplace interventions are implemented. The proposed framework includes steps that the ergonomists can take in order to engage stakeholders in the ergonomic evaluation process.

The merits of the proposed framework, however, can only be determined by its practical application in work rehabilitation programs. Validation of the framework in the field is beyond the purpose of this dissertation; however, this process is highly encouraged as a follow-on step since the framework has excellent potential for improving ergonomics practices in disability management. The main rationale for utilization of the framework going forward is the fact that ergonomists with experience in the field were chiefly responsible for providing the main information for the elaboration of the framework and, therefore, the actions proposed are closely linked with real-life practices (user-friendliness).

In spite of the high potential of success for the utilization of the framework in practice, it is important to highlight its main limitations. First, our knowledge today of obstacles to RTW from a system ergonomics perspective is very limited. In Chapter 5 (Study 2) an initial identification attempt was made in terms of rehabilitation ergonomic variables from a system model. Many psychosocial work factors and physical demands presented have been empirically studied; still many other potential ergonomic variables need to be investigated further in relation to chronic disability. A second limitation of the framework is that there is a need for ergonomic tools tailored to rehabilitation/RTW programs. Again, Chapter 6 (Study 3) presents an initial attempt to identify potential tools for this context. Due mainly to these two limitations the framework represents a preliminary version and thus it is suggested that in the future -- as new knowledge on ergonomic factors and tools

are developed — new information on the evaluation content and tools should be incorporated to the framework. Its main structure, however, should be kept since it is based on strong practical and scientific foundations as described in Chapter 7.

The added value of this dissertation goes beyond the possible future utilization of the framework by ergonomists. It has provided empirical information on: 1) the interdisciplinary engagement in the environment of work; 2) the perspectives of ergonomists regarding what work system elements are targeted within the context of rehabilitation/RTW programs; 3) the current state of knowledge and familiarity of ergonomists with methods applied in this same context; and 4) the various aspects of current ergonomic practices in rehabilitation/RTW that lack scientific support. The focus of all studies presented was on low back disability, since this problem is predominant in these programs (Halpern, 1992; Guzman et al., 2007b). It is possible that many of the principles and issues set forth for the development of the framework are relevant to other musculoskeletal disabilities. However, it is beyond the scope of this investigation to consider other conditions beside back pain except as they relate by analogy. Comparisons of the findings with other types of musculoskeletal disability might be beneficial with certain reservations since all the questions addressed here were specific to LBD.

Furthermore, the qualitative approach used in all three studies and their exploratory nature led to the identification of new phenomenon not mentioned previously in the ergonomic literature for rehabilitation of back pain. For instance, Chapter 6 identified specific aspects in which ergonomists and researchers need closer collaboration in order to understand each others needs and more effectively address these needs for the benefit of disability management and prevention. Also, the findings of the three studies underscored the importance of facilitating an open dialogue about ergonomics practices among all rehabilitation professionals (i.e. psychologists, physicians, occupational therapists, physiotherapists, nurses, etc), as well as with key stakeholders (i.e. insurance and workplace actors) (Chapter 5).

Since many rehabilitation programs utilize an interdisciplinary team model, it is necessary to pose various questions in an effort to achieve a higher level of

team/inter-organization communication and mutual goal planning at every step of the disability evaluation process. Ergonomists working in this environment need to utilize a practice model that can lead to effective channels for teamwork (Chapter 4 and 5). One of the main challenges in conducting this research was the lack of a clear definition of the appropriate assigned responsibilities of ergonomists working in rehabilitation. Since many occupational rehabilitation services have undergone recent transformations in scope and nature, it is still early to determine the exact role ergonomists can play. Nonetheless, the need for a conceptual model for ergonomics practice in this field is evident. This dissertation provides important theoretical hypotheses for future investigations of ergonomic practice models. The inventory of ergonomic work factors presented in Chapter 5 and based on the Work Compatibility Model may represent a theoretical path for such studies.

8.2 Final conclusion

This dissertation was initiated with the idea of building blocks of information for the development of a framework for the ergonomic evaluation process based on scientific principles and practical knowledge. Although the decision-support framework is rather preliminary since its main foundation was built from exploring a new and underdeveloped field of practice, ergonomists are highly encouraged to apply the proposed framework in their practice. This recommendation is based on a need –emanating from both practice and research – for a more formalized evaluation process to facilitate practice standardization and communication among different parties. These are essentials elements that need to be studied in the future in order to assure application of ergonomic best practices as part of work rehabilitation.

While ergonomics is no doubt important for rehabilitation/RTW programs, it should be viewed it as one component of a broader effort needed to minimize the impact of LBD. With that in mind, this research makes very important contributions to the advancement of knowledge in rehabilitation ergonomics. Recommendations for bringing this type of practice closer an evidence-based model were made by: 1) synthesizing empirical knowledge on RTW factors from an interdisciplinary perspective through study I; and 2) raising researchers awareness to practical

realities through studies II and III. The final contribution of this dissertation was to propose a formal approach to the evaluation process which might help ergonomists to more efficiently assess the realm of the workplace. This formal approach may be an asset when one wishes to set the boundaries of applying ergonomics in this field according to an interdisciplinary collaboration model. Further research is required in order to determine its usefulness as a collaborative asset, as well as to test its impact on determining appropriate solutions for reducing the burden associated with LBD.

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APPENDICES

APPENDIX A: DESCRIPTION OF THE ELEMENTS OF THE WORK COMPATIBILITY FRAMEWORK (STUDY II)

	Domain	Description
Acting compatibility	Organizational environment	Comprises all variables aimed at the design and development of the organization; e.g., the organizational structure, task meaningfulness, time organization, task variety, division of labor, work shift, adequacy of rest allowances, authority, policies, decision-making, etc.
	Technological environment	Physical components (machines and tooling) and non-physical components (software, knowledge and techniques) that enable the person to perform their job. It includes the adequacy of tools, equipment, machinery, work flow input, technical procedures, technical supervision and job training.
	Physical environment	Consists of the state of physical (chemical, biological or mechanical) elements or variables surrounding the workstation such as temperature, fall hazards, confining space, building design, personal protective equipment, workspace layout, vibration or ventilation that could potentially have an influence on task performance.
	Economic growth	Monetary policies intended to reward the person. It includes any type of financial incentive such as benefits, job security, promotion, or performance bonuses.
	Individual growth	Activities aimed at the development or utilization of skills, knowledge or allowing innovation as a result or part of the job.
	Social and communication environment	Any personal interactions with different business stakeholders such as co-workers, management and clients. Includes conflict, support, praise, feedback, team relations, etc
	Mental task content	Mental activities (cognitive, sensory, memory-related and information processing) that are job responsibilities.
	Physical task content	Variables related to the physical properties of the body, such as strength, endurance, range of motion, or agilities in order to execute the job such as handling and posture.
Experienced compatibility	Work effort	The level of workload perceived by the person to complete the requirements of the job. For example, how hard does the individual work physically and/or mentally to accomplish the level of performance?
	Perceived risk and benefit	The perceived risks or benefits from work tasks and environment. For instance, the fear of getting injured or the gain of improving health as a result of the execution of the job.
	Work performance	The influence of reaching or not reaching the standards of productivity, quality and safety set by the job. It relates to achieving job goals/expectations in terms of amount of work output or quality of work output.
	Psychological impact	The impact of work tasks/environment/outcomes on the psychological state of the person as perceived by the person. Primarily the level of satisfaction or dissatisfaction caused by the overall work environment.

Note: All descriptions were adapted from Genaidy et al., 2005.

APPENDIX B: GLOSSARY OF WORK VARIABLES EVALUATED IN STUDY II

Work variables	Description
1. Anthropometric issues	Physical body measurements in relation to job design
2. Business type	Self-explanatory
3. Commitment to health and safety	Either the employer's or the organization's level of engagement with H&S.
4. Company/employer's size	Self-explanatory
5. Corporate culture of the company	The organization's norms and value systems.
6. Employer acceptance of proposed erg. Intervention	The level of support given by the employer on what the ergonomist proposes as workplace intervention/solution
7. Employer flexibility regarding the RTW	Employer openness to the proposed RTW plan by the rehabilitation team.
8. Exposure to vibration – level	The intensity/degree of the exposure to vibration.
9. Exposure to vibration - time	The frequency and/or duration of the exposure to vibration
10. Exposure to vibration - type	The type of vibration exposure (i.e., whole body or a body segment)
11. Financial issues of the company	All aspects of finance related to the company or institution that might affect the employee's job situation (e.g. the financial resources available to provide training to workers, costs related to workplace redesign, company's bankruptcy, etc)
12. Floor condition	Self-explanatory
13. Frequency of the task*	The number that represents how often the employee is required to perform a particular task according to his/her pace and the production requirement
14. Goals & preferences regarding RTW	Workers' goals and preferences regarding RTW
15. Job certification	Any specific career development certification or license required for the job
16. Job content	The nature of the work assignments and related activities such as the required physical effort, the required physical skills, the required intelligence and mental skills, etc.
17. Job title	Self-explanatory
18. Level of job rotation*	The degree of job rotation scheme available according to job levels (hierarchy)
19. Level of mental workload	The intensity/degree of the general mental workload required from the employee
20. Level of physical fatigue	The intensity/degree of the general physiological fatigue the worker's possesses as a result of diminished physical capacity to do his/her work
21. Level of task complexity	The intensity/degree of the cognitive complexity of a particular task
22. Level of task difficulty	The intensity/degree of the physical difficulty of a particular task as perceived by the worker
23. Manual handling demands - level	The intensity/degree of handling activities (e.g. heavy or not, hard or easy, etc.)

24. Manual handling demands - Lifting characteristics	The description of lifting activity such as the weight and bulkiness of the object, reach distances, etc.
25. Manual handling demands - time	The frequency and/or duration of handling activities.
26. Manual handling demands - Type	Handling activities (e.g. pushing, pulling, lifting, etc.) required in the job
27. Nature of work accident	Information related to the type and/or course of the employee's work accident (It is the history and nature of the accident/injury)
28. Pace of task performance	Employee's adopted working rhythm according to his/her working style
29. Pace required in the job	The speed/rate required in the job mainly according to production demands or workload
30. Perceived effort	The intensity of physical effort perceived by the worker to accomplish his/her job
31. Perceived mental demands *	Employee's perception of the intensity of the mental demand(s) of his working task(s)
32. Physical capacity	Employee's general tolerance and ability to perform certain job tasks
33. Postural demands - time	The frequency and/or duration of the adopted postural stress/demand
34. Postural demands - type	The adopted body position that might pose a body stress (e.g. asymmetrical posture, twisting the trunk, or any static posture)
35. Production demands	Any requirement of the company/organization related to its wealth that may impact work process or the operating structure. It may depend on the type of industry sector or business type.
36. Readiness to RTW	Workers' prompt willingness to RTW
37. Recovery time*	Work periods when either task demands are light or rest breaks are scheduled, which allows the employee to recover from heavy effort work such as prolonged fixed postures (also called rest allowances).
38. Relationship with co-worker	The employee's relationship with his/her co-worker(s)
39. Relationship with employer	The employee's relationship with his/her employer
40. Relationship with supervisor	The employee's relationship with his/her supervisor
41. Repetitive motion demands - time	The frequency and/or duration of repetitive body part movements
42. Repetitive motion demands - type	Body part movements considered an overuse of human joints (e.g. repetitive wrist extension or flexion of trunk)
43. Safety issues	Any aspects of occupational safety including the use of personal protective equipment, adequacy of equipment used, etc
44. Seating characteristics	Aspects of seat design including functionality measurements and seating conditions
45. Self-regulation RE work break periods	Employee's level of autonomy to make a decision or control when he/she should take a break
46. Skill demands - level	The intensity/degree of specific abilities/proficiencies required to perform the job
47. Skill demands - type	The kind of proficiency or abilities required to perform the job

48. Task(s) performed	Descriptive information regarding all tasks that are/were performed by the employee
49. Teamwork structure	The way a group of workers organize themselves to form a social unit with regards to either the number of members or team functionality (e.g., relatively rigid structure, leadership coordination, etc)
50. Time in each task *	The amount of time required to complete a task, in minutes or hours
51. Union involvement in the RTW process	Self-explanatory
52. Vehicle characteristics	The description of any aspect of a vehicle operated by the employee (e.g., its condition, type, measurements and its purpose)
53. Work experience in field	It is the "footprint" of his/her past work history with regards for instance to the "number of years in the field or his/her overall level of experience"
54. Work related stress	The adverse reaction experienced by an employee to excessive pressure or other types of demand such as: conflict in the workplace, too much workload, high level of job responsibility, etc.
55. Work schedule	Self-explanatory
56. Work season	A type of work which has to be done in a specific period, for instance when business reach its peak, during harvest or any kind of seasonal work.
57. Work shift	The time period during which the employee works if different than a standard working day
58. Work technique	The method chosen by the worker for the realization of certain activities (usually a way of doing a body movement or gesture)
59. Working posture description	The descriptive characteristic of the body position of the employee during his/her work activities
60. Working Tools - Design characteristics	The description of the tool(s) with regards to its condition and design
61. Working Tools – Exposure-time	The frequency and/or duration on which the employee uses the tool or tools
62. Working Tools - type	The type of the tools used by the employee to do his/her job
63. Workplace layout	The description of any aspect of the workstation or work area and its design characteristics
64. Workplace receptivity	The social welcoming atmosphere or structure of the workplace (in French 'Structure d'accueil')

Notes:

1. These descriptions were obtained primordially from the codebook material prepared for a content analysis of a previous study and represent extractions from raw data (verbatim) of interdisciplinary discourses (Costa-Black et al., 2007). A revision was made of the description of these items during the NGT. New items are marked with a symbol (*).

2. "Safety issues" was split into two because of two different aspects covered: one referred to the use of personal protective equipment and the other was related to the availability of technological environment.

APPENDIX C: DESCRIPTIONS FOR EACH RATING SCORE OF THE UTILITY FEATURES (STUDY III)

1. Adapted to various workplace situations: it is the application of the tool to different job types (i.e. occupations) and tasks.

0 = only for a specific occupation or task;
+ = for a few occupations or tasks;
++ = for several occupations or tasks.

2. Easy data collection & analysis: it is how easily the information can be obtained and analyzed.

0 = requires complex data collection and/or analysis;
+ = easy to use but requires time or expertise in data collection and analysis;
++ = very easy to use both in obtaining and analyzing data.

3. Meaningful data: it refers to the meaning of data output to the disability status.

0 = it assesses work factors for injury reduction or occurrence based mainly on normative population data;
+= It assesses work factors for reducing the risk of re-injury or for optimizing performance in general;
++ = it assesses work factors associated with chronicity or disability/RTW outcomes (e.g. duration, compensations, etc).

4. Reliable: determined by identified reliability studies;

0 = no studies found on reliability;
+ = one study can be found in one type of reliability with satisfactory results;
++ = more than 1 study can be found in more than one reliability type with satisfactory results.

5. Valid: determined by identified validity study;

0 = no studies found on validity;
+ = one study can be found in one type of validity with confirmatory results;
++very = more than 1 study can be found in more than one validity type with confirmatory results.

APPENDIX D: LIST OF DEFINITIONS

Below the definitions used in this dissertation are clarified. Note that the definitions used in literature are not always equally interpreted. As a result the definitions presented partly deviate from the ones used in some of the referred literature. The main reference for each of the term is provided. For the terms which a reference is not listed, it means either the definition was extracted from the American Heritage® Dictionary of the English Language (2003), or defined by the author.

Capacity: the maximum ability of a person to perform in a given set of condition.

Disability management: is an active process of minimizing the impact of impairment (resulting from injury, illness, or disease) on the individual's capacity to participate competitively in the work environment (note; rehab services are part of that) (Shrey & Lacerte, 1995).

Efficiency: the effectiveness with which a task or operation is done; usually measured in energy spent, cost, or time required.

Epistemology: is a branch of philosophy concerned with the nature and scope of knowledge. It primarily addresses the following questions: "What is knowledge?", "How is knowledge acquired?", and "What do people know?"

Ergonomics: the design and engineering of human machine systems for the purpose of enhancing human performance." While optimizing human performance is the ultimate objective in ergonomics, each determinant of optimum human performance, such as safety, health, quality, well-being and productivity, is an important part of this objective (Dempsey et al., 2000).

Ergonomic work evaluation: is a process to collect and analyze data related to the work situation of a person, including the job demands and work-related environmental characteristics that can influence individual and organization performance. It is conceptually different than job analysis in which the goal is to accurately define the job of a person.

Evidence-based practice: is a "conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients (Sackett et al., 1996)

Framework: work is a basic conceptual structure used to solve a complex issue.

Human-at-work system: all aspects that encompass variables related to the human being and his/her work and work environment. It is also referred as human-work interface. This definition is according to an ergonomics point of view. In the occupational rehabilitation literature this system is usually referred as the person-environment interactions or the person-environment fit.

Job analysis: a process to accurately define the job, i.e. determine and identify duties, tasks, and functions in a job, together with the skills, knowledge, and responsibilities required of the worker. It is accomplished through measurement, observation, and interviews (Chengalur et al., 2004)

Job design: the arrangement of tasks over a work shift, whether in terms of the distribution of light and heavy physical work or the arrangements of rest breaks in a mentally or perceptually demanding task (Chengalur et al., 2004)

Low back disability: is defined as a condition where the employee has continuously lost time away from his/her job associated with back pain. The work absence is four weeks or more depending if the condition is in subacute or chronic stages (Frank et al., 1998; Tousignant et al., 2000).

Manual handling: lifting, lowering, conveying, pushing, pulling, or sliding an object in order to move it from one place to another by hand(s).

Methodology: A body of practices, procedures, and rules used by those who work in a discipline or engage in an inquiry; a set of working methods.

Musculoskeletal disorders (MSDs): disorders of the muscles, tendons, ligaments, joints, cartilages, nerves, blood vessels or spinal discs.

Productivity: the amount of good product completed during a shift in relation to the number of people and amount of money needed to produce it.

Rehabilitation ergonomics: an interdisciplinary filed of science aiming at adjusting material work and life environment. It assists the rehabilitation process, accelerating integration of the disabled into society (Nowak, 1999).

Rehabilitation interface: the point which data is aggregated in rehabilitation.

Reasoning: is the use of logical thinking in order to find results or draw conclusions.

Stress: the effect of a physiological, psychological, or mental load which may produce fatigue and degrade a person's proficiency.

Transdisciplinarity: the unity of knowledge about a real-world complexity beyond disciplines.

Work environment: the physical, chemical, biological, organizational, social and cultural factors surrounding a person within his/her workplace (ISO, 6385 2001).

Workplace: the physical area in which a person performs job activities.

Work rehabilitation: is defined here as a specific programming - on or off the job - utilizing rehabilitation methods (exercise, real or simulated activity, education and training) to bring an injured or ill worker up to or as close as possible to the level of the essential functions of the job (Isernhagen, 2006b).

APPENDIX E: DECISION MATRIX OF AVAILABLE TOOLS

How to use it:

The list of methods presented in this matrix (next page) corresponds to those recommend to rehabilitation/RTW according to a literature review and analysis presented in Chapter 6. In order to select a method, identify decision criteria that are pertinent to the case or consider total score. Notice that they have been grouped into three phases - i.e. methods for the identification of the problems and situation in the workplace; those that can be used for an in-depth analysis of work factors, or methods that can be used on both phases. This classification was based on the general purpose of the method.

Design of the scoring system:

1) The weights assigned were 0, 1 or 2 and the description of each one is presented in Appendix C;
2) The total score represents the sum of the scores of all criteria without any additional weighing factor since all these criteria were considered equally important to rehabilitation according to a panel of experts (Chapter 6);
3) Low scores are 2 & 4; medium scores are 6 & 7; high scores are 8 & 9.

	Criteria / Methods	Adapted to various workplace	Easy data collect. & analysis	Meaningful data	Reliable	Valid	Total score
IDENTIFICATION OF PROBLEM PHASE	Dictionary of Occupational Titles (DOT)	2	n/a	0	1	1	4
	Job Content Questionnaire (JCQ)	2	1	1	2	2	8
	Job Demands Analysis (JDA)	2	?	?	0	0	2
	Job Description Questionnaire (JDQ)[λ]	1	2	1	2	1	7
	Position Analysis Questionnaire (PAQ)	2	0	1	2	2	7
	Work Role Functioning Questionnaire (WRFQ)	2	1	2	2	2	9
BOTH	AET job analysis method	2	1	1	2	2	8
	Borg Rated Perceived Exertion (RPE)	2	2	1	2	2	9
	Fleishman Job Analysis Survey (F-JAS)	2	1	1	2	2	8
	OVAKO Working posture Analyzing System (OWAS)	2	1	1	2	1	7
IN-DEPTH ANALYSIS PHASE	Biomechanical model of lifting tasks	0	1	0	0	1	2
	Lifting Guidelines for people with LB Disorders	0	1	2	0	1	4
	Lumbar Motion Monitor (LMM)	1	0	1	1	1	4
	NIOSH lifting equation	0	2	0	2	2	6
	Organizational Policies and Practices (OPP)	2	1	2	2	2	8
	Rodgers Muscle Fatigue Assessment (MFA)[◊]	1	1	1	0	1	4
	Snook's tables[ρ]	1	1	1	2	2	7
	3D (2D) Static Strength Prediction Program	1	1	1	0	1	4

Comments_____

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APPENDIX F: WORKSHEET OF THE SHARED KNOWLEDGE ON WORK-RELATED FACTORS IMPACTING ABSENTEISM AND/OR RTW

	Classification of the work system	List the work-related factors identified	Are there any interactions identified?	Data obtained by WHOM?
HUMAN ELEMENT	Physical workload			
	Mental workload			
	Individual capacities			
TASK ELEMENT	Human-task interactions			
	Use of tools and equipments			
	Work activities			
ENVIRONMENT ELEMENT	Physical environmental			
	Organizational elements			
	Social elements			

About this worksheet:

Professional ergonomists are compelled to evaluate the work situation as a system composed of three main components: the human element in the system; the task that needs to be performed with tools and equipments; and the environment in which the work must be performed. These main work system components compose an interactive system that can generate work stressors, which in turn result in work strains, affecting not only individual performance but also productivity, production quality and associated costs. Hence, in characterizing a work system problem for rehabilitation/RTW is necessary to have an overview of these components cited above (i.e. human-task-environment) in relation to the interdisciplinary exchange of information. This worksheet specifies the information about work-related factors that is collected collaboratively on the various components of the work system.